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# A DEA-based Malmquist Productivity Index for Analysing University Performance and Competitiveness

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## ABSTRACT

**Objective:** To conduct a comparative analysis of university performance and competitiveness for leading Polish and Ukrainian universities using the constant returns to scale (CRS) results-oriented model and DEA-based Malmquist productivity index.

**Research Design & Methods:** Using the CRS results-oriented model and DEA-based Malmquist productivity index, an assessment of the efficiency of Polish and Ukrainian higher education institutions in 2019–2021 has been carried out. Sources of data include reports from university rectors, international educational rankings and data from the SciVal Scopus database. The use of input and output indicators, which characterise the didactic and research activities of universities and affect their efficiency, has been justified. Input indicators are the number of university teachers, total university costs calculated per employee, total university costs calculated per student, and output indicators including the number of graduates, the annual number of employee publications in Scopus indexed journals, and the number of citations of employee publications according to SciVal Scopus.

**Findings:** First, the productivity of some Polish and Ukrainian universities differ, as do the factors of the growth of that productivity. Second, more reputable universities (including benchmarking units) have less potential for productivity growth than less productive regional

universities. The relevance of the results obtained was guaranteed by the size of the group of universities analysed. That number was larger than the minimum for maintaining a sufficient number of degrees of freedom.

**Implications/Recommendations:** As a result of analysis with the application of performance--oriented CRS model and Malmquist index, it was found that large reputable universities have less potential for productivity growth (this applies to benchmarking units mainly in Poland). Ukrainian universities are not only more diversified in terms of indicator dynamics, but have greater reserves of productivity growth.

**Contribution:** The article contributes to the scientific literature on university performance and the evaluation of competitiveness. The use of the CRS model and Malmquist index in the analysis of university competitiveness enables better characterisation and evaluation of the input and output indicators, identify benchmarking units and productivity growth reserves.

**Article type:** original article.

**Keywords:** DEA, Malmquist index, universities, efficiency, competitiveness, international rankings.

**JEL Classification:** I23, O47.

## 1. Introduction

Increasing the efficiency and competitiveness of higher education institutions (HEIs) in modern conditions is essential for many socio-economic reasons: changing demographic trends and increased competition among universities for students, more restrictive financial constraints due to the impact of permanent crisis phenomena, increasing pressure on public entities due to these limitations, globalisation trends, and the permanent need to improve the performance of universities for increased competitiveness, achieve success and high positions in international educational rankings. This contributes to the growing interest in evaluation issues and the search for ways to improve the efficiency of university operations. On issues of comparative evaluation, it is interesting to use international experience in identifying ways to increase the efficiency of universities and the factors that can provide such an increase.

The quantitative nonparametric data envelopment analysis (DEA) method has been used quite extensively in evaluating the effectiveness of universities. Since the basic version of the DEA method, known as CCR (Charnes, Cooper & Rhodes, 1978), was proposed, it has been developed extensively. CCR assumes the occurrence of constant returns to scale (CRS) – that is, a linear dependence between outputs and inputs, and a modification of the DEA method allowing for the presence of variable returns to scale (VRS) (Banker, Charnes & Cooper, 1984). Following the authors' last names, the modification goes by the acronym BCC (Banker, Charnes,

Cooper). More than 4,000 articles have been written about DEA by some 2,500 authors from more than 50 countries (Emrouznejad, Parker & Tavares, 2008). The decision-making units used in DEA analyses have equally defined inputs and outputs. Focused on the performance of specific public functions, these units are mostly not profit-oriented. In assessing their performance, the efficiency of management with defined resources is measured without reference to financial coefficients only. This has led the DEA method to be widely used in the study of public sector units (Chalos & Cherian, 1995; Odeck, 2005; Nazarko *et al*., 2008).

The Malmquist index based on DEA (Färe *et al*., 1994; Chen & Ali, 2004; Johnes, 2006; Fu, Song & Guo, 2009) is used to measure productivity change over time. It can be decomposed into two parts, including for measuring technology change and efficiency change. Comparative studies of universities have employed the Malmquist index based on DEA to analyse universities in the EU (Parteka & Wolszczak-Derlacz, 2013; de la Torre, Gómez-Sancho & Perez-Esparrells, 2017), Switzerland (Bolli & Farsi, 2015), the United Kingdom (Johnes, 2006), and Australia (Worthington & Lee, 2008).

However, when it comes to the application of the DEA method, there are relatively few publications that link the issues of university efficiency and competitiveness. Some authors (Nazarko *et al*., 2008) point out that in comparative studies of the efficiency of the operation of public sector units, evaluation through the identification of benchmarks can be treated as a substitute for competitiveness and thus contribute to the efficient allocation of public funds, attention to the efficiency of implemented processes, improvement of the quality of services provided and improvement of the management of public institutions.

## 2. Methodology

An important element in this analysis of the Polish and Ukrainian higher education system is a comparison of the competitive positions of the countries' higher education institutions. It will enable us not only to understand their evolution but, more importantly, to define the prospects for changes in the higher education sector in Ukraine, especially in terms of greater integration with the European Union after the war, as the country begins to be rebuilt.

The Malmquist index, based on DEA, was used to analyse the change in productivity over time of the most competitive Polish and Ukrainian universities. The information limitations that arose during the data search were taken into account.

The purpose of the analysis using DEA will not be to identify the most competitive units on the scale of entire countries, but to determine which of the leader universities designated according to their position in international rankings perform better and which perform worse. This means that this study makes an *a priori* assumption that the universities being compared have a high level of competitive-

ness, and the purpose of the analyses will be to see how a given university relatively – that is, in relation to the other universities under study – manages to achieve a given level of performance, using the inputs it has. Effective universities will be identified, i.e. those that, compared to the others, use the smallest number of inputs to achieve a given result. To achieve this goal, the following steps were followed:

– select Polish and Ukrainian universities-leaders of international rankings,

– determine the inputs and outputs for DEA analysis taking into account the analysed factors of competitiveness of the HEIs,

– analyse indicators from reports issued by the rectors of Polish and Ukrainian universities-leaders of international rankings, indicators from SciVal Scopus database and The Times Higher Education World University Rankings,

– conduct a DEA analysis of inputs and outputs of the universities with the application of CRS-O models for selecting benchmarking units,

– analyse inputs and outputs with the application of the Malmquist index, based on DEA.

The CRS-O model was chosen for assessing the efficiency of Polish and Ukrainian higher education institutions for a couple of reasons. First, decision--making units operate under the same scale efficiency, meaning they all use inputs and outputs in the same proportion. Second, CRS-O is simpler and easier to interpret than VRS-O. It assumes that any deviations from efficiency are solely due to managerial decisions, technology, or other factors unrelated to scale efficiency.

The Malmquist productivity change index is defined as the geometric mean of the productivity change rates in period $t$ and $t + 1$. In the results-oriented ($M_0$) model, it is calculated according to the following formula (Färe *et al*., 1994):

$$M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \left[ \left( \frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \right) \cdot \left( \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)} \right) \right]^{1/2}. \quad (1)$$

$M_0 > 1$ indicates an increase in productivity, $M_0 < 1$ indicates a decrease in productivity, and $M_0 = 1$ indicates no change in productivity from time $t$ to $t + 1$.

The Malmquist index can be decomposed into two components (Färe, Grosskopf & Weber, 1989; Färe *et al*., 1992):

$$M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \left( \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \right) \cdot \left[ \left( \frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)} \right) \cdot \left( \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right) \right]^{1/2}. \quad (2)$$

*EC* is the efficiency change index. This index measures the change in technical efficiency over two periods (i.e., whether the unit is approaching its efficiency limit over time):

$$EC = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)}. \quad (3)$$

*TC* is the index of technology change in two periods (i.e., the frontier moves over time):

$$TC = \left[ \left( \frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)} \right) \cdot \left( \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right) \right]^{1/2}. \quad (4)$$

When these indices have a value higher than one, a change for the better has occurred – that is, productivity has risen.

## 3. Competitiveness, Efficiency and International Education Rankings: How to Identify the Most Competitive Universities?

Ukraine, like several other post-Soviet economies, at the beginning of the transition had a relatively high share of population with higher education and a high enrolment rate. This has not changed significantly. Currently, the gross enrolment rate in Ukraine is 83% (compared to 69% in Poland, World Bank, 2019b). This is one of the highest indicators in Europe. At the same time, Ukraine spends a lot on education (5.4% of GDP compared to 4.6% in Poland, World Bank, 2019a). However, given Ukraine's relatively low GDP, these expenditures are *de facto* lower than in EU countries. Such high enrolment rates prompt questions about the graduates' professional paths. The analysis of the structure of Ukrainian GDP, as well as the place of Ukraine in the global value-added chain, does not indicate that there is an above-average demand for the labour with higher education in this economy. One therefore wonders how effective expenditures on education actually are.

Despite the two countries' differing general economic situations and financial inputs, Ukraine and Poland had roughly similar positions in international educational rankings in higher education prior to the war. For example, in the 2020 Universitas 21 Ranking (Universitas 21, 2020), Poland ranked 32nd and Ukraine 36th. If, however, the results are adjusted for a country's level of wealth, Poland is ranked 29th and Ukraine 14th – well above expectations. In 2020, in the evaluation of the resources component (including public expenditures, general expenditures, university expenditures on research and development) Poland ranked 31st in the ranking, Ukraine 27th; in the assessment of the environment component (quantified presentation of the political and regulatory environment, the degree of balance of the student and teacher population structure by gender) – Poland ranked 17th, Ukraine 39th; in the evaluation of the communication component (which includes interaction with business and industry, number of foreign students, academic publications prepared with foreign partners, and Internet communication) Poland ranked 37th and Ukraine 38th; in the results component (including research and its impact, availability of world-class universities, workforce qualifications) Poland ranked 31st, and Ukraine 42nd. For number of papers published, Poland ranked 18th and

Ukraine 45th. At the same time, Poland's rank for the average impact factor for publications was 32nd, while Ukraine ranked 50th.

Table 1. Ukrainian and Polish University – Leaders of International Education Rankings in 2021

| University | Ranking | | |
|---|---|---|---|
| | Web of Universities | The QS World University Rankings | The Times Higher Education World University Rankings |
| Ukrainian universities | | | |
| National Taras Shevchenko University of Kyiv (KNU) | 1 (1,162) | 2 (601–650) | 4–9 (1,001+) |
| Sumy State University (SumDU) | 3 (1,796) | 4–5 (701–750) | 1–2 (501–600) |
| National Technical University of Ukraine Kyiv Polytechnic Institute (NTUU KPI) | 2 (1,597) | 4–5 (701–750) | 4–9 (1,001+) |
| Kharkiv National University VN Karazin (KhNU) | 4 (2,380) | 1 (477) | 4–9 (1,001+) |
| National Technical University Kharkiv Polytechnical Institute (NTU KhPI) | 5 (2,542) | 3 (651–700) | 4–9 (1,001+) |
| Kharkiv National University of Radio Electronics (NURE) | 8 (2,667) | – | 3 (801–1,000) |
| National Aerospace University Kharkiv Aviation Institute (NAU KhAI) | 6 (2,578) | – | – |
| Lviv Polytechnic National University (LPNU) | 10 (2,923) | 6 (801–1,000) | 1–2 (501–600) |
| National University of Life and Environmental Sciences of Ukraine (NULES) | 7 (2,605) | – | – |
| Ivan Franko National University of Lviv (IFNUL) | 13 (3,226) | – | 4–9 (1,001+) |
| Polish universities | | | |
| Jagiellonian University (UJ) | 1 (321) | 2 (326) | 1 (501–600) |
| University of Warsaw (UW) | 2 (321) | 1 (321) | 3 (801–1,000) |
| Warsaw University of Technology (PW) | 4 (512) | 3 (511–520) | 4–19 (1,000+) |
| AGH University of Science & Technology (AGH) | 3 (429) | – | 4–19 (1,000+) |
| Poznan University of Technology (PP) | 7 (723) | – | – |
| Adam Mickiewicz University (UAM) | 5 (557) | – | 4–19 (1,000+) |
| Medical University of Warsaw (WUM) | 14 (990) | – | 2 (801–1,000) |
| Nicolaus Copernicus University (UMK) | 6 (661) | – | 4–19 (1,000+) |
| University of Wroclaw (UWr) | 8 (754) | – | 4–19 (1,000+) |
| Silesian University of Technology in Gliwice (POLSL) | 9 (842) | – | 4–19 (1,000+) |

Source: Web of Universities (Webometrics.info, 2021a, 2021b), The QS World University Rankings (Top Universities, 2021), The Times Higher Education World University Rankings (Times Higher Education, 2021a, 2021b).

The competitiveness of universities is strictly related to their efficiency: high efficiency leads to better outcomes, and thus a university with high efficiency represents itself respectably in international and national rankings. The most competitive Polish and Ukrainian universities in this study are determined with the use of international educational rankings Web of Universities, The QS World University Rankings, and The Times Higher Education World University Rankings. These rankings were chosen because the largest number of Polish and Ukrainian universities are presented in these rankings. Unlike most university rankings (The QS World University Rankings, The Times Higher Education World University Rankings, Academic Ranking of World Universities and others), there are no range places in the Web of Universities rankings, so the position of each university is precisely determined. So that their progress could be checked, I also analysed, in 2019–2020, the list of the most competitive universities designated in 2021. The top 10 universities were determined by calculating the geometric mean of the universities' positions in these rankings (Table 1).

In this study, 60 university rector reports (30 Ukrainian and 30 Polish) for 2019–2021 were analysed. The content and number of indicators used in the reports from Ukrainian universities, despite certain aspects that are required for inclusion in these reports, differ greatly. According to the results of the analysis, the most useful information and indicators were in the reports from the Rector of National Taras Shevchenko University of Kyiv. The scope and content of the reports, in addition to the issues determined by the legal regulations on the implementation of the rectors' employment agreements, also related to the scale of the university and the specifics of the prevailing corporate culture. As for the Polish universities, the reports from the University of Warsaw, Jagiellonian University, and Adam Mickiewicz University contain the most information. The number of indicators and their level of detailing in the various rectors' reports also varies.

## 4. Input and Output Indicators Used in the Analysis with DEA Method

In conducting a DEA analysis it is essential to determine the inputs and outputs of universities that will be used in the evaluation and the size of the group of universities analysed in the study. In most of the studies, both input and output ratios characterise teaching and research activities. This is primarily due to the definition of the concept of technical efficiency of universities as the ratio of the results of university activities (number of graduates or publications) to inputs (number of people employed, revenues).

In studies conducted for Polish universities using DEA (e.g., Wolszczak-Derlacz, 2015), the following indicators are used: the value of the university's revenue,

the number of researchers and students, the results of scientific activity (number of publications), and teaching activity (number of graduates).

In a more extended list of indicators (e.g., Wolszczak-Derlacz, 2018), the following can also be applied to assess the technical efficiency of the activities of higher education institutions: number of employees (academic staff, non-academic staff by grade and position); number of teaching hours performed by academic staff; financial resources (the value of revenue by source), costs by form of incurrence, assets, premises conditions (e.g., laboratory space). Outputs include: number of publications by employees with the affiliation of the university, citation rates, impact indicators, number of degrees and titles awarded; number of graduates (number of bachelor's, master's degrees); number of students (e.g., advancing to higher years, obtaining a given number of ECTS credits); results from tests and examinations, e.g., results from graduation examinations, grades on diplomas, patents, industrial designs, numbers and value of contracts with external entities; amount of funds obtained for scientific activities from external sources, value of research services sold.

In some studies of the effectiveness of Polish higher education institutions, only indicators of didactic or research activities are analysed. For instance, in a study of the effectiveness of didactic activities of higher education institutions (Brzezicki, 2017), it was pointed out that, depending on the empirical model chosen, either the total number of academic teachers (full-time and part-time) or the total value of didactic revenue could be included as inputs, while outputs could include either the total number of students (full-time and part-time) including foreigners or the total number of graduates (full-time and part-time) including foreigners.

Table 2. Input-output Indicators in the DEA Model

| Indicator | Description of the Indicator |
|---|---|
| Input indicators | |
| The number of university teachers ($x_1$) | One of the variables that characterises the human resource potential of a university. It has a direct impact on publication activity rates. That the majority of employees are engaged in research and publication activity is an important condition for working at a university. The source of empirical data is The Times Higher Education World University Rankings and reports of rectors of Polish and Ukrainian universities |
| Total university costs calculated per employee, in euro ($x_2$) | Measures the expenditure on teaching and research activities by universities. The use of a cost indicator calculated per employee makes it possible to compare universities of different scales. Due to gaps in the information available, a more appropriate indicator of total costs of scientific activity was not used in the study. Data from Poland and Ukraine, expressed in national currency, were reduced to a common unit – the euro. Data are sourced from rector reports of the higher education institutions |

Table 2 cnt'd

| Indicator | Description of the Indicator |
|---|---|
| Total university costs calculated per student, in euro ($x_3$) | Reflects expenditures on teaching and research activities. For research purposes, it would also be worthwhile to use the indicator of total costs of teaching-only activities for the analysis, but such data is not available for every university. While this lack of data more characterises Ukrainian HEIs, data is not presented in the rectors' reports of all Polish HEIs. To ensure comparability between HEIs of different scales, the cost indicator is calculated per student |
| Output indicators | |
| The annual number of employee publications in Scopus indexed journals ($y_1$) | An indicator worth including in the evaluation of scientific performance. It characterises not only the publication activity of scientists with a university's affiliation, but also the quality of the publications. The data source is the SciVal Scopus database, which currently presents information on the number of publications between 2012 and 2021 |
| The number of citations of employee publications according to SciVal Scopus ($y_2$) | Can be used to assess the quality of scientific publications. It was taken from the SciVal Scopus database and is available for Polish and Ukrainian universities for the 2012–2021 period. The citation index will be used for the three study periods: 2012–2019, 2012–2020 and 2012–2021 |
| The number of graduates ($y_3$) | One of the main quantitative indicators characterising the didactic performance and scale of HEIs. It does not take into account the quality of education. However, quality can be characterised – for example, by the brand of university alumni graduated from |

Source: the author.

Table 2 provides a brief description of all the variables used in this study for Polish and Ukrainian universities follows. It also identifies the source of the empirical data and justifies their selection for the model.

To calculate the minimum size of the group of objects analysed in the study using the DEA method, in order for there to be a sufficient number of degrees of freedom, the number of universities (denoted by $n$) should be at least (Domagała, 2009, p. 146):

$$n_{\min} = \max\{m \cdot s; 3 \cdot (m + s)\}, \tag{5}$$

where: $m$ is the number of inputs and $s$ is the number of outputs.

This condition is treated as a so-called strong recommendation, but not as a condition for the solvability of DEA models. It arose as a result of simulation studies and should be treated as a certain practical rule, which they call the "rule of thumb" (Domagała, 2009, p. 146). In this study, the number of inputs and outputs is 3, so the number of universities studied can be in such a range: (9; 18). The actual number is higher and represents 10 Polish and 10 Ukrainian HEIs, the indicators of which are analysed for the years 2019–2021.

Indicators of inputs and outputs of Ukrainian and Polish universities-leaders of international education rankings in 2019–2021 are presented in Tables 3 and 4.

Table 3. Input Indicators of Ukrainian and Polish Universities-leaders of International Education Rankings in 2019–2021

| University | Number of University Teachers | | | Total University Costs Calculated per Employee, in Euro | | | Total University Costs Calculated per Student, in Euro | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2019 | 2020 | 2021 | 2019 | 2020 | 2021 |
| Ukrainian universities | | | | | | | | | |
| KNU | 2,944 | 2,974 | 2,707 | 26,545.2 | 23,169.8 | 30,207.9 | 3,488.8 | 2,966.4 | 3,452.2 |
| SumDU | 902 | 854 | 815 | 23,808.3 | 25,985.6 | 32,033.5 | 2,334.3 | 2,388.0 | 2,810.9 |
| NTUU KPI | 2,249 | 2,206 | 2,063 | 28,169.6 | 30,205.8 | 36,210.5 | 3,274.6 | 3,249.5 | 3,545.1 |
| KhNU | 1,755 | 1,804 | 1,839 | 12,985.4 | 13,842.3 | 15,236.2 | 1,418.2 | 1,459.5 | 1,637.3 |
| NTU KhPI | 1,673 | 1,597 | 1,518 | 12,131.3 | 13,022.4 | 15,371.1 | 1,490.9 | 1,550.3 | 1,921.4 |
| NURE | 773 | 765 | 635 | 15,641.3 | 14,200.3 | 21,939.3 | 1,386.5 | 1,192.3 | 1,728.9 |
| NAU KhAI | 684 | 692 | 622 | 30,730.3 | 29,447.1 | 32,861.7 | 3,127.0 | 3,294.6 | 3,251.1 |
| LPNU | 2,047 | 2,091 | 2,031 | 14,316.8 | 14,250.9 | 20,917.5 | 1,301.5 | 1,382.1 | 1,945.2 |
| NULES | 1,144 | 1,337 | 1,151 | 21,833.6 | 19,077.8 | 25,837.0 | 1,648.3 | 1,583.6 | 1,840.0 |
| IFNUL | 1,897 | 1,886 | 2,124 | 11,738.2 | 14,275.8 | 15,706.8 | 1,222.7 | 1,660.0 | 1,789.2 |
| Polish universities | | | | | | | | | |
| UJ | 2,984 | 3,035 | 3,068 | 76,561.6 | 67,899.6 | 68,405.8 | 5,422.6 | 5,074.7 | 5,515.0 |
| UW | 3,834 | 3,894 | 3,974 | 96,322.0 | 90,670.3 | 92,074.5 | 7,422.8 | 6,993.7 | 8,850.2 |
| PW | 2,429 | 2,473 | 2,492 | 84,404.9 | 78,395.3 | 79,923.1 | 6,473.2 | 6,525.7 | 8,170.7 |
| AGH | 2,216 | 2,093 | 2,100 | 85,198.7 | 82,940.6 | 90,992.9 | 6,042.5 | 6,065.5 | 7,659.0 |
| PP | 1,429 | 1,326 | 1,332 | 57,124.2 | 59,783.1 | 60,727.1 | 6,779.4 | 6,683.4 | 6,909.4 |
| UAM | 2,733 | 2,832 | 2,842 | 60,762.0 | 57,643.6 | 61,689.1 | 4,413.0 | 4,337.7 | 5,076.7 |
| WUM | 1,798 | 1,816 | 1,885 | 51,542.4 | 51,204.3 | 50,205.0 | 9,385.6 | 9,296.7 | 9,357.9 |
| UMK | 2,324 | 2,363 | 1,946 | 52,092.6 | 50,810.9 | 61,900.3 | 5,114.6 | 5,351.0 | 5,477.9 |
| UWr | 1,597 | 1,604 | 1,595 | 71,288.7 | 72,542.2 | 74,803.6 | 4,853.3 | 5,034.1 | 5,381.6 |
| POLSL | 1,641 | 1,638 | 1,630 | 68,705.9 | 69,214.3 | 73,151.1 | 6,227.0 | 5,491.3 | 6,664.2 |

Source: The Times Higher Education World University Rankings 2019–2021, reports of rectors of Ukrainian and Polish universities.

In the structure of the total costs of Ukrainian HEIs, the costs of teaching combine those of the general and special fund under the expenditure item "Training of personnel by HEIs and ensuring the functioning of their practice bases", and the costs of scientific activity under the item "Scientific and scientific-technical activities of HEIs and scientific institutions". The majority of Ukrainian HEIs, shown

in Table 3, are large HEIs with more than 15,000 students (the HEIs under analysis here have an average of 15,299 students). The average number of students per one employee in 2019–2021 was 9.98, while the average share of foreign students was 7.3%. The total costs in the calculation per student at the the most competitive universities surveyed are much higher than, for example, the average educational costs per student (2,178 euro/year in the years 2019–2021), which in the academic year 2020/2021 in Ukraine accounted for 1,479.6 euro/year.

Table 4. Output Indicators of Ukrainian and Polish Universities-leaders of International Education Rankings in 2019–2021

| University | The Number of Graduates | | | The Annual Number of Employee Publications in Scopus Indexed Journals | | | The Number of Citations of Employee Publications According to SciVal Scopus | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2019 | 2020 | 2021 | 2019 | 2020 | 2021 |
| Ukrainian universities | | | | | | | | | |
| KNU | 3,767 | 3,296 | 2,870 | 1,556 | 1,778 | 1,781 | 80,196 | 88,790 | 93,756 |
| SumDU | 468 | 441 | 437 | 400 | 575 | 617 | 23,787 | 28,027 | 31,131 |
| NTUU KPI | 2,146 | 1,871 | 2,190 | 898 | 1,007 | 1,012 | 25,433 | 29,433 | 31,788 |
| KhNU | 1,106 | 1,153 | 1,280 | 860 | 904 | 941 | 32,092 | 35,167 | 37,180 |
| NTU KhPI | 2,085 | 1,617 | 1,555 | 522 | 544 | 582 | 13,438 | 15,151 | 16,214 |
| NURE | 1,595 | 930 | 823 | 452 | 327 | 389 | 9,202 | 10,440 | 11,215 |
| NAU KhAI | 786 | 663 | 464 | 219 | 268 | 247 | 8,319 | 9,231 | 10,069 |
| LPNU | 2,092 | 2,157 | 2,935 | 1,102 | 657 | 1,323 | 34,084 | 39,451 | 42,872 |
| NULES | 2,643 | 2,275 | 2,341 | 351 | 513 | 592 | 7,634 | 9,772 | 11,282 |
| IFNUL | 3,931 | 2,488 | 2,922 | 567 | 657 | 620 | 20,565 | 22,879 | 24,106 |
| Polish universities | | | | | | | | | |
| UJ | 7,946 | 7,773 | 8,146 | 3,966 | 4,248 | 4,725 | 609,759 | 658,962 | 687,945 |
| UW | 9,027 | 8,933 | 9,109 | 3,214 | 3,401 | 3,448 | 454,457 | 493,033 | 512,859 |
| PW | 6,321 | 5,432 | 5,723 | 2,397 | 2,396 | 2,490 | 246,975 | 268,986 | 280,027 |
| AGH | 8,313 | 6,571 | 6,120 | 2,597 | 2,508 | 2,699 | 283,894 | 307,633 | 323,283 |
| PP | 4,715 | 4,492 | 4,602 | 1,198 | 1,300 | 1,237 | 104,421 | 114,741 | 122,530 |
| UAM | 6,873 | 7,270 | 7,040 | 1,868 | 1,925 | 2,024 | 196,479 | 213,812 | 225,066 |
| WUM | 2,121 | 2,095 | 2,129 | 1,753 | 1,933 | 2,424 | 213,508 | 236,760 | 253,985 |
| UMK | 6,102 | 5,085 | 4,847 | 1,407 | 1,713 | 2,056 | 138,010 | 157,093 | 167,859 |
| UWr | 5,758 | 5,659 | 5,807 | 1,320 | 1,427 | 1,495 | 140,714 | 151,828 | 158,527 |
| POLSL | 5,094 | 4,735 | 4,647 | 1,840 | 1,725 | 1,813 | 119,375 | 134,200 | 145,167 |

Source: The Times Higher Education World University Rankings 2019–2021, SciVal Scopus database data, reports of rectors of Ukrainian and Polish higher education institutions, GUS (2022).

Most of the Polish universities are large (the average number of students is 26,728), with the average number of students per employee in 2019–2021 standing at 11.96 (19.8% more than in Ukrainian universities). Foreign students comprise 4.8% of the student body. The total costs in the calculation per student in the most competitive universities in the period under review are much higher (6,402 euro/year) than the average educational costs per student in the country, which in the 2020/2021 academic year in Poland accounted for 5,355.5 eurou/year.

The publication activity indicators of Ukrainian universities-leaders of international educational rankings are lower than those of Poland. Employees publish less in Scopus-listed journals (on average, 742 for Ukrainian univeristies *versus* 2,285 for Polish ones), and a much lower number of citations of publications (according to SciVal Scopus, 28,423 in the years 2012–2019 for Ukrainian universities *versus* 270,730 for Polish universities).

## 5. Is the Productivity of the Benchmarking Units Increasing Faster?

As a result of DEA analysis with the application of CRS models and input-output indicators that characterise the teaching and research activities of Polish and Ukrainian universities, benchmarking units were determined (Table 5).

Table 5. Results of the DEA Analysis Conducted Using CRS Models for Ukrainian and Polish Universities in 2019–2021

| University | 2019 | 2020 | 2021 | Comments |
|---|---|---|---|---|
| Ukrainian universities | | | | |
| KNU | 1.000 | 1.000 | 1.000 | Benchmarking unit |
| SumDU | 1.033 | 1.000 | 1.000 | Benchmarking unit (reserves +1.1%) |
| NTUU KPI | 1.393 | 1.308 | 1.335 | There are reserves of efficiency increases, on average +34.5% |
| KhNU | 1.059 | 1.000 | 1.000 | Benchmarking unit (reserves +2.0%) |
| NTU KhPI | 1.321 | 1.265 | 1.422 | There are reserves of efficiency increases, on average +33.6% |
| NURE | 1.000 | 1.152 | 1.074 | There are reserves of efficiency increases, on average +7.5% |
| NAU KhAI | 1.509 | 1.361 | 1.667 | There are reserves of efficiency increases, on average +51.2% |
| LPNU | 1.000 | 1.000 | 1.000 | Benchmarking unit |
| NULES | 1.000 | 1.000 | 1.000 | Benchmarking unit |
| IFNUL | 1.000 | 1.000 | 1.000 | Benchmarking unit |

Table 5 cnt'd

| University | 2019 | 2020 | 2021 | Comments |
|---|---|---|---|---|
| Polish universities | | | | |
| UJ | 1.000 | 1.000 | 1.000 | Benchmarking unit |
| UW | 1.149 | 1.151 | 1.174 | There are reserves of efficiency increases, on average +15.8% |
| PW | 1.258 | 1.315 | 1.316 | There are reserves of efficiency increases, on average +29.6% |
| AGH | 1.000 | 1.000 | 1.031 | Benchmarking unit (reserves +1.0%) |
| PP | 1.137 | 1.006 | 1.039 | There are reserves of efficiency increases, on average +6.1% |
| UAM | 1.000 | 1.000 | 1.043 | Benchmarking unit (reserves +1.4%) |
| WUM | 1.363 | 1.315 | 1.198 | There are reserves of efficiency increases, on average +29.2% |
| UMK | 1.000 | 1.203 | 1.219 | There are reserves of efficiency increases, on average +14.1% |
| UWr | 1.040 | 1.000 | 1.000 | Benchmarking unit (reserves +1.3%) |
| POLSL | 1.092 | 1.102 | 1.108 | There are reserves of efficiency increases, on average +10.1% |

Source: the author.

As a result of the DEA analysis, four benchmarking units were selected for Ukrainian universities with an efficiency index of 1.0 and two universities with very small efficiency growth reserves. For Polish universities in the period under review, the benchmarking unit is Jagiellonian University. Another three universities (AGH University of Science and Technology, Adam Mickiewicz University in Poznan, University of Wroclaw) have very small reserves of efficiency growth. On average, the efficiency of the Ukrainian universities studied can be increased by 13.0%, and the Polish ones by 10.9%. This means the Polish universities are more technically efficient than Ukrainian ones. Table 6 shows the results of the DEA analysis in R with the application of the Malmquist index, which targeted results using the CRS model.

The results show that the annual productivity growth for Ukrainian universities in 2020/2019 averaged 11.7%, while in 2021/2020 the reduction came in at 2.9%. Such a large change is due to the falling rate of technological progress. For Polish universities, the reduced productivity in 2020/2019 averaged 1.4%, while in 2021/2020 it was +1.5%. In 2020–2021, the decrease in productivity was partly attributable to the impact of the COVID-19 pandemic, which has led to a switch

to distance learning in many universities and long-term educational losses for the educational systems of many countries.

Table 6. Results of DEA Analysis with Application of Malmquist Index for Ukrainian and Polish Universities in 2019–2021

| University | 2020/2019 | | | 2021/2020 | | |
|---|---|---|---|---|---|---|
| | MPI | TC | EC | MPI | TC | EC |
| Ukrainian universities | | | | | | |
| KNU | 0.9034594 | 0.9034594 | 1.0000000 | 1.0793780 | 1.0793780 | 1.0000000 |
| SumDU | 0.7919759 | 0.8180762 | 0.9680956 | 0.8927729 | 0.8927729 | 1.0000000 |
| NTUU KPI | 0.9257438 | 0.9853598 | 0.9394983 | 0.8943993 | 0.8768872 | 1.0199708 |
| KhNU | 0.9765926 | 1.0346257 | 0.9439090 | 1.0581683 | 1.0581683 | 1.0000000 |
| NTU KhPI | 1.1522060 | 1.2031554 | 0.9576535 | 1.0711057 | 0.9531288 | 1.1237786 |
| NURE | 1.4212119 | 1.2337473 | 1.1519473 | 0.7950779 | 0.8531480 | 0.9319343 |
| NAU KhAI | 1.0040678 | 1.1130255 | 0.9021067 | 1.0754687 | 0.8780219 | 1.2248769 |
| LPNU | 1.1287767 | 1.1287767 | 1.0000000 | 0.9851570 | 0.9851570 | 1.0000000 |
| NULES | 1.2617942 | 1.2617942 | 1.0000000 | 0.9015151 | 0.9015151 | 1.0000000 |
| IFNUL | 1.6004716 | 1.6004716 | 1.0000000 | 0.9615963 | 0.9615963 | 1.0000000 |
| Polish universities | | | | | | |
| UJ | 0.9710112 | 0.9710112 | 1.0000000 | 0.9068051 | 0.9068051 | 1.0000000 |
| UW | 1.0066776 | 0.9869611 | 1.0199769 | 0.9769474 | 0.9753796 | 1.0016074 |
| PW | 0.9620124 | 0.9608952 | 1.0011627 | 1.0891855 | 1.0418630 | 1.0454210 |
| AGH | 1.0063715 | 0.9757196 | 1.0314147 | 1.0952684 | 1.0952684 | 1.0000000 |
| PP | 1.0007285 | 0.9689844 | 1.0327602 | 0.9858730 | 1.1145663 | 0.8845351 |
| UAM | 1.1173965 | 1.0708293 | 1.0434871 | 0.9293164 | 0.9293164 | 1.0000000 |
| WUM | 0.8277415 | 0.9088231 | 0.9107840 | 0.9159594 | 0.9495724 | 0.9646020 |
| UMK | 0.9989369 | 0.9861455 | 1.0129711 | 1.1530935 | 0.9582016 | 1.2033934 |
| UWr | 0.9867733 | 0.9867733 | 1.0000000 | 1.0306801 | 1.0723713 | 0.9611224 |
| POLSL | 0.9876691 | 0.9827367 | 1.0050190 | 1.0691428 | 1.0589286 | 1.0096458 |

Notes: MPI – Malmquist productivity index, TC – technology change index, EC – efficiency change index.

Source: the author's own calculations.

2022 was an extremely difficult year for Ukrainian universities – hopes for the end of the COVID-19 pandemic and the transition to normal work remained unrealised. Worse still, according to the Ministry of Education and Science of Ukraine (2024), more than 70 universities have been damaged during the full-scale war with Russia (more than 10 were completely destroyed). Universities in the Kharkiv region

suffered the most (1 destroyed, 29 damaged); Donetsk (3 destroyed, 10 damaged), and Mykolaiv region (5 damaged). The priority for Ukrainian universities today is therefore to ensure safety during the educational process, gradually rebuild damaged buildings, and protect students and staff as much as possible.

Since the beginning of the war, professors emigrating has also been a significant challenge for Ukrainian universities. In 2022 more than 4,800 university teachers went abroad – 4.9% of the total number in Ukraine (Ministry of Education and Science of Ukraine, 2022, p. 199). Some have found jobs or internships under programmes that support Ukrainian scientists in continuing their research. This large-scale emigration could take an outsize toll on the Ukrainian economy, while attracting young, highly skilled professionals will be a boon for the EU economy.

## 6. Conclusions

As a result of analysis with the application of performance-oriented CRS model and Malmquist index, it was found that large, reputable universities have less potential for productivity growth (this applies to benchmarking units mainly in Poland). Ukrainian universities are not only more diversified in terms of indicator dynamics, but have greater reserves of productivity growth. However, poor funding significantly limits their growth opportunities. The increase in technical efficiency may primarily be associated with improving the quality of scientific articles and increasing the internationalisation of scientific research. Publishing more in English, and using the language more widely on campuses would be a large step in this direction. It would also boost their competitiveness and improve their position in international educational rankings.

Assessing the war's toll on the higher education system, educational losses due to the decline in the quality of education, and various aspects of effective post-war reconstruction of the educational system are all important areas for further research. Doing so would help save the research and educational potential of Ukrainian universities while increasing their competitiveness in the educational services market.

### Conflict of Interest

The author declares no conflict of interest.

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# The Metaverse: The Essence, Research Streams, and Potential Applications in Marketing

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## ABSTRACT

**Objective:** The objective of this article is to identify the main research streams and research gaps relating to the metaverse in management sciences, particularly in the field of marketing.
**Research Design & Methods:** The researchers employed a systematic analysis of the literature to achieve their objective. They reviewed and examined various sources to identify the essence of the metaverse and ascertain the areas and directions of research pertaining to this concept.
**Findings:** The metaverse is envisioned as a virtual universe comprising numerous 3D virtual worlds where consumers, their avatars, and brands coexist and interact. Initially, the metaverse concept emerged in computer games set in complex, closed universes. However, in 2021, major technology companies like Facebook determined that the metaverse would be the next stage in virtual environment development, resulting in heightened interest from both practitioners and researchers. Despite being the subject of research across multiple scientific disciplines for years, the conceptualisation of fundamental metaverse concepts and its essence remains in an early stage, lacking a consensus.

**Implications/Recommendations:** The findings of this study emphasise the need for further research and exploration in the field of management sciences, particularly within marketing, to comprehensively understand and define the metaverse. The evolving nature of the metaverse calls for collaborative efforts from both practitioners and scientists to unravel its potential implications for businesses and consumers.

**Contribution:** This study contributes to the existing literature by presenting a systematic analysis of the metaverse concept within the context of management sciences, focusing on marketing. By identifying gaps and highlighting key areas of investigation, the research lays the groundwork for future studies in this rapidly evolving domain.

**Article type:** original article.

**Keywords:** metaverse, marketing, systematic literature review, VOSviewer.

**JEL Classification:** M31, O33.

## 1. Introduction

Considered as a new connection platform for Web 3.0, the metaverse is predicted to fundamentally change the way consumers and companies interact, communicate, create, and capture value. There is an intensive debate, in both the academic and business world, regarding the possible applications and implications of this new, disruptive technology, as well as its directions of evolution (Ario *et al*., 2022; Park & Kim, 2022; Tan & Salo, 2023). Like many innovations at the very early stage of development, the metaverse is subject to contradictory assessments (Shen *et al*., 2021; Bian *et al*., 2022; Dwivedi *et al*., 2022; Rosenberg, 2022). Many welcome it enthusiastically as a powerful technological mega-trend, that will radically transform consumer behaviour, and as a result, marketing practice (Shen *et al*., 2021). Others criticise it as a fad, that would eventually share the fate of its predecessors (Rosenberg, 2022; Dwivedi *et al*., 2023). However legitimate, this scepticism seems to ignore both the fundamental differences between the current and the early (such as Second Life) versions of the metaverse, and the differences in the market conditions surrounding their introductions (Park & Kim, 2022). While in the past the early metaverse platforms were accessed through PCs, now they are accessed through mobile and virtual reality devices at any time and in any place. Current technological developments allow the generation of far more immersive virtual environments, with greater realism, and stimulation of multiple senses – offering consumers a more "natural" and seamless user experience. From the consumers' perspective, the widespread use of social media and adoption of NFT blurred the boundaries between the real and virtual worlds, with younger generations of consumers in particular not perceiving them as being in opposition (Nokia & Ipsos, 2022). Last but not least, the COVID-19 pandemic not only proved the usefulness

of technologies facilitating non face-to-face activities, but also enforced their rapid adoption by great numbers of consumers to continue with their professional and private lives. Because of these differences, scientific studies of the metaverse are necessary, including the definition of the concept itself, consumer acceptance, motivations to use and engage with metaverse environments.

The objective of the article is to identify, based on the systematic literature review:

1) the research streams related to the metaverse in the context of marketing,

2) the main research gaps relating to the applications of the metaverse in the management sciences, particularly in the field of marketing.

## 2. Definition of the Metaverse

Since 2021, when Facebook rebranded to Meta and Mark Zuckerberg (Ball, 2022) announced the decision to invest in this next iteration of the Internet, the term metaverse has received growing attention from many scientific disciplines, evidenced by the soaring numbers of publications. This created the need for a comprehensive definition, well grounded in research, and broadly accepted across diverse areas of science (Weinberger, 2022). "Metaverse" is a compound word, combining "meta" (transcendence, beyond, virtual, or abstract) with "universe" (world) (Lee & Kim, 2022). Literary endeavours have made numerous efforts to conceptualise and establish a clear definition of the metaverse (Trunfio & Rossi, 2022). One definition put forth describes it as "a virtual and augmented reality--based representation of a three-dimensional space, where individuals can utilise personalised avatars to engage in work, recreation, and synchronous communication with one another" (Trunfio & Rossi, 2022, p. 103). Weinberger (2022) conducted an extensive literature survey and, based on the findings, defined the metaverse as follows: "an interconnected web of ubiquitous worlds partly overlapping with and enhancing the physical world. These virtual worlds enable users represented by avatars to connect and interact with each other, to experience and consume user--generated content in an immersive, scalable, synchronous, and persistent environment. An economic system provided incentives for contributing to the metaverse" (Weinberger, 2022, p. 13). Following the ideas of Park and Kim (2022) and a comprehensive review of 64 scientific articles, Lee and Kim (2022, pp. 615–616) defined the metaverse as "the permanent, immersive mixed-reality world (…) where people and people, people and objects can synchronously interact, collaborate, and live over the limitation of time and space, using avatar, the immersion-supporting devices, platform, and infrastructure". The analysis of the above allows the identification of the elements that, in our opinion, indicate the key characteristics of the current metaverse: avatar, synchronicity, interactivity, persistence, immersion, and ubiquity. The avatar element refers to users expressing themselves via virtual

avatars; synchronicity relates to experiencing the metaverse in real time; interactivity relates to the ability to manipulate objects in the metaverse; persistence refers to how the platform continues operating even when users are not active; immersion reflects how the metaverse mirrors the real world and allows consumers to immerse themselves in the metaverse. Finally, ubiquity refers to availability of the metaverse technology (access to hardware, computing power, and connectivity), the requirement that the metaverse platforms should be ubiquitously accessible from different locations and devices, and the user's virtual persona remain connected during transitions between virtual worlds and technologies. Interconnectedness and interoperability, which are the ability for different platforms to exchange information and interact, are considered important features of the current metaverse, as it includes many environments (Dionisio, Burns & Gilbert, 2013). This multiplicity of virtual universes is highlighted in the definition of the metaverse proposed by Morgado (2009), who emphasises that it is not a single world, but a plethora of interconnected worlds, an idea also stressed by Lee *et al*. (2021). An unlimited number of consumers can simultaneously experience multiple worlds within the metaverse (Hollensen, Kotler & Opresnik, 2023). The metaverse, as defined by Weinberger (2022), encompasses a variety of environments or worlds, ranging from fully virtual realms to those that intersect or mirror the physical world (Davis *et al*., 2009). It exists parallel to the physical world, serving as a virtual or digital layer that overlays it (Weinberger, 2022). These diverse metaverse worlds converge into a collective, persistent, and interactive parallel reality (Trunfio & Rossi, 2022). This, in turn, creates an environment in which consumers can use their personal avatars for multitude of activities, including work, entertaining themselves, playing games, and communicating with each other. The immersive experience in the metaverse is delivered by new technologies such as virtual reality, augmented reality, mixed reality, artificial intelligence, and blockchain. These technologies amplify the sense of immersion and realism for avatars and residents, fostering seamless interactions with various products and brands. Within virtual worlds, avatars, assets, content, and currencies exhibit persistence, meaning they retain a permanent presence. These virtual environments continue to operate even when users are offline (Dionisio, Burns & Gilbert, 2013). The analysis of existing publications also points at the other characteristics of the metaverse, which set it apart from its predecessors such as sociality (embracing multiple economic, cultural, and legal systems) and hyper-spatiotemporality (transcending time and space boundaries) (Ning *et al*., 2021). Although there has been a remarkable increase in the number of academic publications in 2022, the marketing literature concerning the metaverse is still in its early stages. The majority of contributions in this field are focused on the retail sector (Dwivedi *et al*., 2023).

## 3. Materials and Methods

### 3.1. Data Collection

To identify research streams related to marketing in the literature on the metaverse, we used Elsevier's Scopus database. "Scopus is a highly reputed abstract and citation database, that contains significant publications from scholarly journals" (van Eck & Waltman, 2011, p. 2). Scopus encompasses a comprehensive collection of approximately 36,377 titles, with 22,794 active titles and 13,583 inactive titles. These titles are sourced from around 11,678 publishers, and among them, 34,346 are peer-reviewed scientific journals covering various top-level subject fields (Elsevier, 2022). Initially, we also considered the Web of Science (WoS) database, but because of Scopus's wider coverage, the WoS was excluded. As this is a relatively new research subject, we found it crucial to analyse the biggest data set available.

The search query was "TITLE-ABS-KEY (metaverse AND marketing)". This resulted in 60 documents. Next, we limited the initial results to the „business & management", "communication", "hospitality, leisure, sport and tourism" fields, which resulted in 52 documents. Next we focused on published articles in English, excluding editorials, reviews and so on. As a result, 42 documents qualified for further analysis. Citation and bibliographic information, abstracts, keywords, and references of the resultant 42 articles were downloaded in a comma separated file (CSV) from the Scopus database.

### 3.2. Data Analysis

We used Scopus "Analyze search results" tool and VOSviewer 1.6.18 to conduct a series of analyses. "VOSviewer is a freely available software developed for construction, viewing, and presentation of bibliometric maps" (van Eck & Waltman, 2011, p. 1). We used Scopus to identify the most influential authors and countries, and VOSviewer to analyse the keywords, based on their frequency of occurrence and relevance. Based on the results of the analysis of the keywords, a cluster analysis was conducted, which allowed the identification of 6 main research streams in our area of interest.

## 4. Results

The analysis of results from the Scopus database (Fig. 1) allowed the identification of the first publications mentioning the metaverse in the context of marketing. These early works were published in 2009, concurrent to the popularisation of the Second Life platform. The next publications appeared in 2015 and 2021, and were both devoted to retail. In the years 2022–2023 one observes a dramatic growth in the number of publications on the subject, with almost 40 papers published (works dated 2023 are already available).

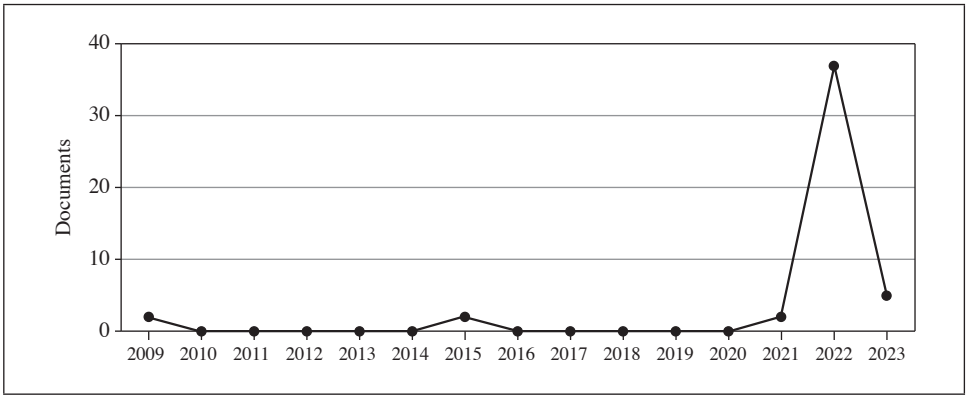


Fig. 1. Number of Documents by Year
Source: Scopus 2022.

Among the publications analysed, the most prolific author was D. Buhalis (Fig. 2), who co-authored 4 articles on the metaverse in the context of marketing. The next was P. A. Rauschanbel, who co-authored 3 articles; the other named authors published at least 2 works on the subject.

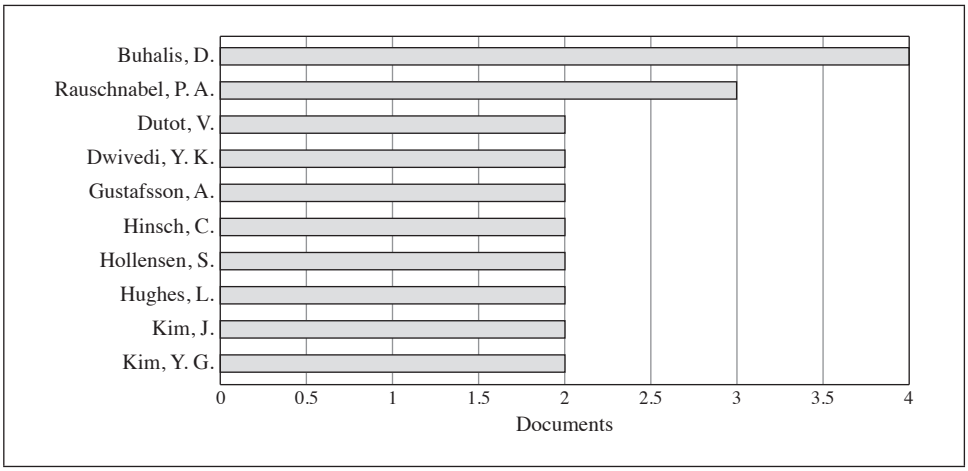


Fig. 2. Documents by Author, Comparison of the Document Counts for up to 15 Authors
Source: Scopus 2022.

The subject of the metaverse attracted most attention from scholars in South Korea, the US, and the UK (Fig. 3).

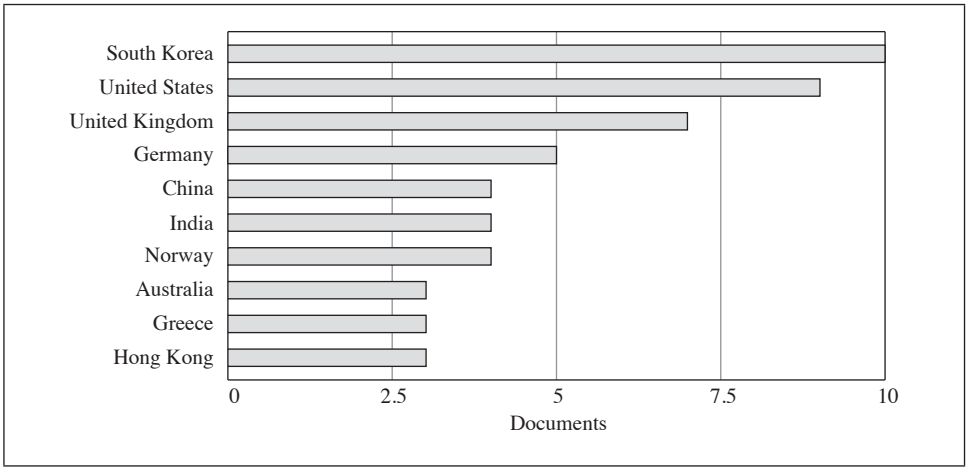


Fig. 3. Documents by Country/Territory
Source: Scopus 2022.

Next, we conducted an analysis of keywords which appeared in the titles and abstracts at least 5 times. 1,657 keywords were analysed, out of which, 63 met the requirements of this study. The assessment of each qualifying keyword's occurrence and relevance involved a specific calculation. Relevance was established by analysing the distribution of (second order) co-occurrences among all noun phrases, which was then compared to the overall distribution of co-occurrences among noun phrases. The Kullback-Leibler distance measured the discrepancy between these distributions, with a larger difference indicating higher relevance for a given noun phrase. Essentially, noun phrases with low relevance, such as "paper", "interesting result", and "new method", which have a general meaning, demonstrated a relatively even distribution of their (second order) co-occurrences (van Eck & Waltman, 2011). 40 keywords with highest relevance were selected for further analysis and grouped with VOSviewer into six clusters (Fig. 4):

1) trust, loyalty and engagement in virtual worlds (7 articles),

2) conceptualisation of the metaverse and other immersive, extended, augmented, virtual, and mixed realities (8 articles),

3) marketing strategy and new generations (10 articles),

4) adoption of the metaverse in different contexts and sectors (8 articles),

5) hospitality and tourism management (3 articles),

6) the concept of metaverse marketing (6 articles).

Cluster 1 (Table 1) includes publications focusing on the presentation of the results of empirical studies of trust, loyalty, emotional and behavioural engagement of users of the metaverse platforms, and blockchain based networks.

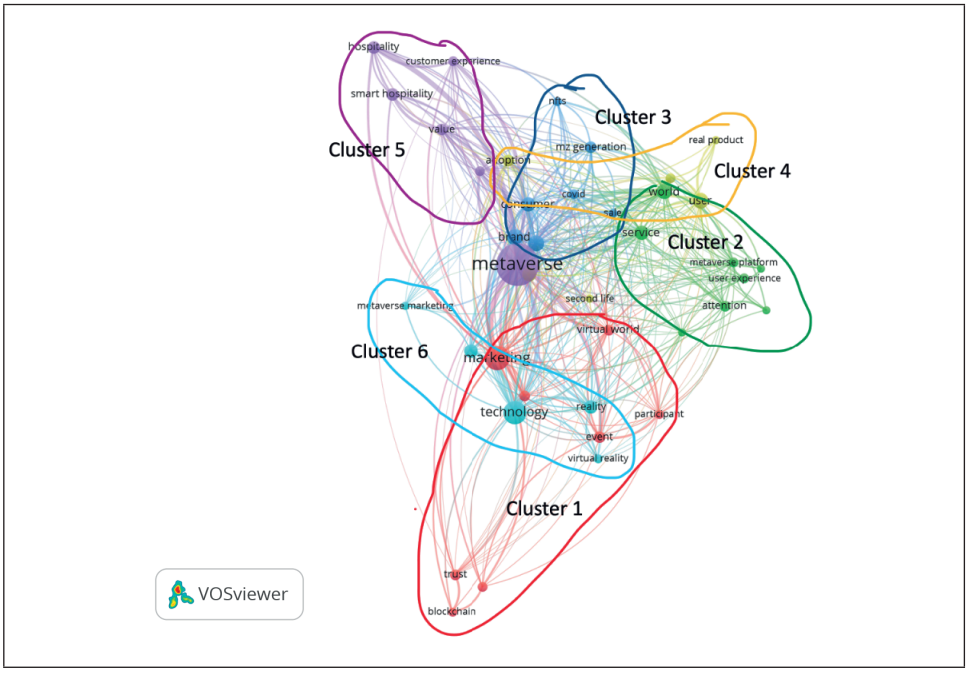


Fig. 4. The Results of Cluster Analysis of the Keywords with VOSviewer
Source: the authors.

Table 1. Trust, Loyalty and Engagement in Virtual Worlds

| Cluster 1 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Avatar | Heo, J. *et al.* | Examining Participant's Perception of SPICE Factors of Metaverse MICE and Its Impact on Participant's Loyalty and Behavioral Intentions | 2023 | *Studies in Computational Intelligence* |
| Blockchain | de Brito Silva, M. J. *et al.* | Avatar Marketing: A Study on the Engagement and Authenticity of Virtual Influencers on Instagram | 2022 | *Social Network Analysis and Mining* |
| Economy | Panagiotakopoulos, D. *et al.* | Digital Scent Technology: Toward the Internet of Senses and the Metaverse | 2022 | *IT Professional* |
| Event | Jeon, J.-E. | The Effects of User Experience--based Design Innovativeness on User – Metaverse Platform Channel Relationships in South Korea | 2021 | *Journal of Distribution Science* |

Table 1 cnt'd

| Cluster 1 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Marketing | Tan, T. M., & Saraniemi, S. | Trust in Blockchain-enabled Exchanges: Future Directions in Blockchain Marketing | 2022 | *Journal of the Academy of Marketing Science* |
| Participant | Tan, T. M., & Salo, J. | Ethical Marketing in the Blockchain-based Sharing Economy: Theoretical Integration and Guiding Insights | 2023 | *Journal of Business Ethics* |
| Trust Virtual world | Jeon, Y. A. | Reading Social Media Marketing Messages as Simulated Self within a Metaverse: An Analysis of Gaze and Social Media Engagement Behaviors within a Metaverse Platform | 2022 | *Proceedings – 2022 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops, VRW 2022* |

Source: the authors, based on VOSviewer.

Cluster 2 (Table 2) consists of articles focusing on presenting the experience of customers of various platforms and technologies aiming at total immersion, which includes augmented reality, virtual reality, extended reality, and a broader conceptualisation encompassing various realities and the metaverse.

Table 2. Conceptualisation of Metaverse and Other Immersive, Extended, Augmented, Virtual and Mixed Realities

| Cluster 2 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Attention | Ario, M. K. *et al.* | Towards an Implementation of Immersive Experience Application for Marketing and Promotion through Virtual Exhibition | 2022 | *Software Impacts* |
| Augmented reality | Wagner, R., & Cozmiuc, D. | Extended Reality in Marketing – a Multiple Case Study on Internet of Things Platforms | 2022 | *Information (Switzerland)* |
| Metaverse platform | Rauschnabel, P. A. *et al.* | What Is Augmented Reality Marketing? Its Definition, Complexity, and Future | 2022 | *Journal of Business Research* |
| Service Social media post | Shim, B. K. *et al.* | A Study on Software Proposals for Optimization of Augmented Reality Glasses | 2022 | *Communications in Computer and Information Science* |

Table 2 cnt'd

| Cluster 2 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Social | Park, S.-M., & Kim, Y.-G. | A Metaverse: Taxonomy, Components, Applications, and Open Challenges | 2022 | *IEEE Access* |
| User experience | Buchholz, F., Oppermann, L., & Prinz, W. | There's More Than One Metaverse | 2022 | *i-com* |
| UXBDI | Dwivedi, Y. K. *et al.* | Metaverse beyond the Hype: Multidisciplinary Perspectives on Emerging Challenges, Opportunities, and Agenda for Research, Practice and Policy | 2022 | *International Journal of Information Management* |
| World | Havele, A. *et al.* | The Keys to an Open, Interoperable Metaverse | 2022 | *Proceedings – Web3D 2022: 27th ACM Conference on 3D Web Technology* |

Source: the authors, based on VOSviewer.

Cluster 3 (Table 3) includes publications focusing on various aspects of marketing strategy in the context of the metaverse, for example brand development, marketing communications strategy (with particular focus on advertising, and content marketing to Z Generation consumers (so called digital natives), considered as the target audience of activities using VR and the metaverse).

Table 3. Marketing Strategy and New Generations

| Cluster 3 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Brand | Ricoy--Casas, R. M. | The Metaverse as a New Space for Political Communication | 2023 | *Smart Innovation, Systems and Technologies* |
| Consumer | Lee, J., & Kwon, K. H. | Sustainable and Safe Consumer Experience NFTs and Raffles in the Cosmetics Market after COVID-19 | 2022 | *Sustainability (Switzerland)* |
| COVID | Bousba, Y., & Arya, V. | Let's Connect in Metaverse. Brand's New Destination to Increase Consumers' Affective Brand Engagement & Their Satisfaction and Advocacy | 2022 | *Journal of Content, Community and Communication* |

Table 3 cnt'd

| Cluster 3 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| MZ generation | Enriquez, D. R. *et al*. | Algorithm for Identification and Analysis of Targeted Advertising Used in Trending Topics | 2022 | *Proceedings of the LACCEI International Multi-conference for Engineering, Education and Technology* |
| NFTs | Koay, K. Y. *et al*. | Social Media Influencer Marketing: Commentary on the Special Issue | 2022 | *Journal of Internet Commerce* |
| Sale | Kim, Y., & Jung, H. | Beauty Industry's Strategic Response to Metaverse Evolution: Focused on Generation MZ | 2022 | *Proceedings – 2022 IEEE/ACIS 7th International Conference on Big Data, Cloud Computing, and Data Science, BCD 2022* |
| Strategy | Chen, C., & Yao, M. Z. | Strategic Use of Immersive Media and Narrative Message in Virtual Marketing: Understanding the Roles of Telepresence and Transportation | 2022 | *Psychology and Marketing* |
| | Patil, K., Bharathi, S. V., & Pramod, D. | Can Metaverse Retail Lead to Purchase Intentions among the Youth? A Stimulus-Organism-Response Theory Perspective | 2022 | *2022 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems, ICETSIS 2022* |
| | Lee, H.-K., Park, S., & Lee, Y. | A Proposal of Virtual Museum Metaverse Content for the MZ Generation | 2022 | *Digital Creativity* |
| | Lee, H. J., & Gu, H. H. | Empirical Research on the Metaverse User Experience of Digital Natives | 2022 | *Sustainability (Switzerland)* |

Source: the authors, based on VOSviewer.

Cluster 4 (Table 4) includes publications concentrating on the possibilities for the adoption of metaverse technology in selected sectors and contexts, such as healthcare, product (furniture) design, retailing and logistics in various countries.

Table 4. Adoption of the Metaverse in Different Contexts and Sectors

| Cluster 4 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Adoption | Musamih, A. *et al.* | Metaverse in Healthcare: Applications, Challenges, and Future Directions | 2022 | *IEEE Consumer Electronics Magazine* |
| Person | Arikan, O. U. *et al.* | Conceptualization of Meta--servitization: 3D Case Study from Furniture Industry | 2022 | *ISMSIT 2022 – 6th International Symposium on Multidisciplinary Studies and Innovative Technologies, Proceedings*<br>*Proceedings of the International Conferences on e-Health 2015, EH 2015, e-Commerce and Digital Marketing 2015* |
| Product | Hassouneh, D., & Brengman, M. | Metaverse Retailing: Are SVW Users Ready to Buy Real Products from Virtual World Stores? | 2015 | *Proceedings of the International Conferences on e-Health 2015, EH 2015, e-Commerce and Digital Marketing 2015* |
| Real product | Bourlakis, M., Papagiannidis, S., & Li, F. | Retail Spatial Evolution: Paving the Way from Traditional to Metaverse Retailing | 2009 | *Electronic Commerce Research* |
| Second Life | Spivey, W. A., & Munson, J. M. | Mot: Technology Entrepreneurs in Second Life | 2009 | *PICMET: Portland International Center for Management of Engineering and Technology, Proceedings* |
| User experience | Njoku, J. N. *et al.* | Prospects and Challenges of Metaverse Application in Data--driven Intelligent Transportation Systems | 2022 | *IET Intelligent Transport Systems* |
| | Chinie, C., Oancea, M., & Todea, S. | The Adoption of the Metaverse Concepts in Romania | 2022 | *Management and Marketing* |

Table 4 cnt'd

| Cluster 4 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| | Bian, Y., Leng, J., & Zhao, J. L. | Demystifying Metaverse as a New Paradigm of Enterprise Digitization | 2022 | *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* |

Source: the authors, based on VOSviewer.

Cluster 5 (Table 5) predominantly includes review articles, focusing on applications of the metaverse in tourism and hospitality, with emphasis on identification of future trends and developments.

Table 5. Hospitality and Tourism Management

| Cluster 5 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Customer experience | Buhalis, D., O'Connor, P., & Leung, R. | Smart Hospitality: From Smart Cities and Smart Tourism towards Agile Business Ecosystems in Networked Destinations | 2022 | *International Journal of Contemporary Hospitality Management* |
| Future Value | Buhalis, D., Lin, M. S., & Leung, D. | Metaverse as a Driver for Customer Experience and Value Co-creation: Implications for Hospitality and Tourism Management and Marketing | 2022 | *International Journal of Contemporary Hospitality Management* |
| Hospitality Metaverse platform, smart hospitality | Gursoy, D., Malodia, S., & Dhir, A. | The Metaverse in the Hospitality and Tourism Industry: An Overview of Current Trends and Future Research Directions | 2022 | *Journal of Hospitality Marketing and Management* |

Source: the authors, based on VOSviewer.

Cluster 6 (Table 6) consists of publications that analyse the concept of metaverse marketing in the most comprehensive way, presenting it as a new environment for marketing activities and innovative approaches to consumer research.

Table 6. The Concept of Metaverse Marketing

| Cluster 6 | Publications | | | |
|---|---|---|---|---|
| Keywords | Authors | Title | Year | Journal |
| Internet | Gao, S. | Research on the Innovation of the Internet of Things Business Model under the New Scenario of Metaverse | 2022 | *ACM International Conference Proceeding Series* |
| Metaverse marketing | Sartamorn, S., & Oe, H. | Metaverse Marketing for Community Development: Revitalization of Traditional Industrial Sectors in Thailand | 2022 | *Springer Proceedings in Business and Economics* |
| Reality | Rosenberg, L. | Marketing in the Metaverse and the Need for Consumer Protections | 2022 | *2022 IEEE 13th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference, UEMCON 2022* |
| Technology | Hollensen, S., Kotler, P., & Opresnik, M. O. | Metaverse – the New Marketing Universe | 2022 | *Journal of Business Strategy* |
| Virtual reality | Giang Barrera, K., & Shah, D. | Marketing in the Metaverse: Conceptual Understanding, Framework, and Research Agenda | 2023 | *Journal of Business Research* |
| | Dwivedi, Y. K. *et al.* | Metaverse Marketing: How the Metaverse Will Shape the Future of Consumer Research and Practice | 2022 | *Psychology and Marketing* |

Source: the authors, based on VOSviewer.

## 5. Opportunities for the Application of the Metaverse in Marketing

Both marketing scholars and practitioners are currently engaged in intense debates regarding the marketing implications that may arise from the potential mainstream adoption of the metaverse. Most of the assessment of possible applications of the metaverse to marketing practice is currently found in professional publications. Their authors assume that the adoption of the metaverse by the mainstream would be similar to the Internet (Deloitte, 2022). The wide adoption of the metaverse by companies and their customers, and its eventual technological maturity should allow the full exploitation of the marketing opportunities it offers (Shen *et al.*, 2021). McKinsey & Company (2022) forecasts that the value of direct product sales could reach $54 billion. The pioneers of marketing in the metaverse are fashion and luxury companies, such as Gucci, which use metaverse platforms to

interact with and engage consumers, as well as for testing it as a new sales channel for virtual products. In a rather fragmented discourse one can identify a few key areas of marketing practice in which the most transformative opportunities are expected. These can be broadly related to product strategy, marketing communications, branding, retail, hospitality and tourism, and marketing research (Dwivedi *et al*., 2022).

Considering product strategy, the most promising opportunities are expected in the area of product development. This includes not only development of the offerings impossible in the physical world, like new ranges of virtual products, but also improved opportunities for detailed concept and product testing. For example, companies would use the metaverse to quickly test and effectively cost multiple variants of new products, streamlining the process of commercialisation of new products. As for marketing communications, the metaverse is considered a new environment for digital marketing. Companies could test new forms of more personalised and interactive digital advertising – with content and features surpassing currently available media, and customised to a single user. Avatars and virtual influencers in the metaverse could be considered to be the next stage in the evolution of influencer marketing. The metaverse offers seemingly unlimited opportunities for engaging consumers via virtual events such as concerts. To leverage sales, companies could deploy sales promotion activities in the metaverse, such as scavenger hunts and team games. Branding opportunities include using the metaverse to achieve greater awareness and visibility of brands through various promotional activities. The metaverse can serve as either the sole, or an additional brand development and communication environment, depending on the nature of the brand. Specific features of the metaverse, such as 3D, are expected to impact implementation of branding tactics, such as brand content development. Last but not least, the metaverse's social nature promises more flexible and creative opportunities for development of brand communities – a critical area to build consumer loyalty. From the perspective of retail, the metaverse constitutes a new sales channel with possibilities to test engaging sales formats such as virtual pop-up stores. In the metaverse hospitality and tourism are expected to be a powerful trend (for example events and conferences), building on growing demand and immersive experiences. The metaverse technology permits the possibility to transform hospitality experiences into digital formats, which could be more affordable, "digitally stored", transferred and sold, surpassing the limitations of service perishability. For industry, it offers not only access to a new sales channel, but also a platform to build entirely new, unique metaverse products. An area which merits particular attention is marketing research. The immersive features of the metaverse should provide enhanced tracking and monitoring opportunities, and allow access to increasingly dense streams of consumer data in real time. Examples include tracking attention, gathering data about physical reactions to various

marketing stimuli, and responses to interactions with objects. As the metaverse should allow for the collection, storage, and processing of real-time big data, it could facilitate the tracking of changes in demand and consumer preferences. The AI technologies could be applied to predict consumer behavioural patterns, and to personalise offers and marketing communications. Availability of granular participant data about behaviours of consumers should result in better consumer insights. The metaverse is considered to be equally well suited for conducting qualitative and quantitative marketing research, enhancing the effectiveness of traditional techniques of data gathering and allowing development of the new, innovative ones. In fact, new measures and data gathering methods should be developed to suit the specific characteristics of the metaverse (Dwivedi *et al*., 2022). An example of such a novel method is immersive netnography (Kozinets, 2023).

## 6. Challenges

Regardless of the fundamental question whether the metaverse is just another fad or the next iteration of the Internet, there are many challenges that must be addressed at the very early stage of its development. In our opinion, the first one is to understand the motivations of consumers to use the new technology, and to identify the obstacles to its adoption. This would allow companies (platform owners and their business customers) to overcome the likely technical issues, such as easy to use hardware and software, and user-friendly interfaces. The availability and affordability of VR and AR headsets, and accessories are crucial to mainstream adoption of the metaverse, allowing companies to quickly capitalise on the marketing opportunities it is supposed to offer (Pośpiech, 2022). Another crucial factor is the quality of the metaverse experience itself, including its visual reality and capacity for sensory stimulation without causing sensory or cognitive overload. Without attractive content, enhancing or surpassing the already existing alternatives, as well as a seamless user experience, the adoption of the metaverse by consumers may be slower than envisioned by marketing professionals and scholars. There is widespread agreement that the metaverse, creating new avenues for gathering consumer data, generates considerable threats to consumer privacy, and there is a high likelihood of unethical use of this data. On a more abstract level, the metaverse presents the possibility of not only eliminating the constraints of time and space but also challenging social norms, potentially leading to unregulated actions and anarchy (Dwivedi *et al*., 2022). With easy creation of a multitude of identities, consumers may use the metaverse to express their frustrations and desires controlled in the real world. Hence, hypothetically, the metaverse can spur the Proteus effect, with their real-life behaviours affected by their digital avatars (Yee, Bailenson & Ducheneaut, 2009).

## 7. Conclusion

Based on a systematic review of the literature, we have identified six main research streams, within which we have identified research gaps that future work might investigate. Research on the metaverse should address gaps in understanding consumer motivations and adoption barriers, optimising the quality of user experience, addressing privacy and ethical concerns, exploring its impact on social norms and behaviour, and developing innovative methods for consumer research.

Understanding consumer motivations for adopting the metaverse and the obstacles they may encounter, including factors such as ease of use, affordability of hardware, quality of experience, and comparison with existing alternatives, necessitates delving deeper into consumer psychology and behaviour through research.

Assessing the quality of the metaverse experience is essential for understanding its potential appeal to consumers. This includes aspects such as visual realism, sensory stimulation, and user experience design. Research could focus on optimising these factors to ensure a compelling and enjoyable experience for users.

The metaverse presents new challenges in terms of consumer privacy and ethical use of data. Research is needed to explore the potential threats to privacy and ways to mitigate them, as well as ethical guidelines for collecting and using consumer data in the metaverse.

The metaverse has the potential to challenge social norms and influence consumer behaviour in both virtual and real-world settings. Research could investigate how interactions in the metaverse shape attitudes, beliefs, and behaviours.

As the metaverse offers new possibilities for gathering consumer data, research could explore innovative methods for conducting marketing research in this environment. This includes developing new measures and data gathering techniques tailored to the unique characteristics of the metaverse, as well as integrating AI technologies for data analysis and personalisation.

### Authors' Contribution

The authors' individual contribution is as follows: Marcin Awdziej 40%, Dagmara Plata-Alf 20%, Jolanta Tkaczyk 40%.

### Conflict of Interest

The authors declare no conflict of interest.

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# Consumer Awareness and Beliefs Regarding Sustainable Products

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## ABSTRACT

**Objective:** To identify consumer awareness and beliefs regarding sustainable products according to a consumer profile.

**Research Design & Methods:** A quantitative approach was used. A questionnaire containing 24 variables was conducted using an online survey. 570 correctly completed records were obtained. The analysis used the difference test between structure indicators (chi-square), Kruskal-Wallis ANOVA and Mann-Whitney U test.

**Findings:** The best predictors of differences in consumer awareness and attitudes were respondents' education, gender and place of residence. Age and financial situation proved to be weak predictors.
**Implications/Recommendations:** The results make it possible to suggest thematic areas and groups (profiles) of respondents to which educational activities should be directed at various levels of education on the circular economy and sustainable development. Manufacturers seeking to promote product sustainability could also benefit from the study's results.
**Contribution:** The article identifies the product sustainability degree model as well as variables that create a consumer profile and differentiate consumers' awareness and attitudes towards sustainable products. The differences between individuals uare also classified.

**Article type:** original article.

**Keywords:** sustainable product, circular economy, awareness, attitudes, differentiation.

**JEL Classification:** Q01, C38, M31.

## 1. Introduction

Socio-economic progress, dynamic changes and scientific and technological development have negative consequences for the natural environment and, therefore, for human existence. This state results from the discrepancy between the pace of socio-economic progress and the natural ability of the environment to adapt (Sobczyk-Kolbuch, 2019). Social awareness and people's attitude towards the nature around them play an important role in restoring balance between socio-economic development and the environment (Daly & Farley, 2011; Sobczyk-Kolbuch, 2019). Crisis forces us to define a new model for the functioning of production and trade, which will take into account the reduction of the current level of consumption (Inquiry, 2021). Taking into account the survival of civilisation, the importance of issues related to sustainable social and economic development and the circular economy model (circular economy) should be treated as a priority (Archer, 2011; Gates, 2021; Markiewka, 2021).

Sustainable products are a subcategory of sustainable development (SD), growing out of the concept of SD, and at the same time stimulating it (Żuchowski & Żuchowska-Grzywacz, 2018). These products can be balanced in many ways (Leleux & van der Kaaij, 2019; Żuchowska-Grzywacz & Żuchowski, 2020). The first attempts to define sustainable products concerned cosmetics and foods (Żuchowski & Żuchowska-Grzywacz, 2018). These products were created by enriching conventional products with additional values related to their ecological friendliness, guaranteed quality, innovation, social responsibility, ethical behaviour, high health and environmental safety standards and many other constantly improved legal and normative indications (Żuchowski & Paździor, 2022).

In March 2022, the European Commission accepted and sent to the European Parliament a package of measures to make products more sustainable (European Commission, 2022). The direction of this sustainability assumes that, by 2030:

– most of them will be designed for increased operational durability, energy efficiency, recycling and reduced material consumption,

– consumers will be able to make more informed and sustainable purchases through access to information,

– entrepreneurs will remodel their business activities based on the principles of the circular economy.

For the purposes of this article, products are balanced in their circular life cycle in accordance with the principles of ESG (environmental, social, governance). Areas of product sustainability identified in the product sustainability model are presented in Figure 1.

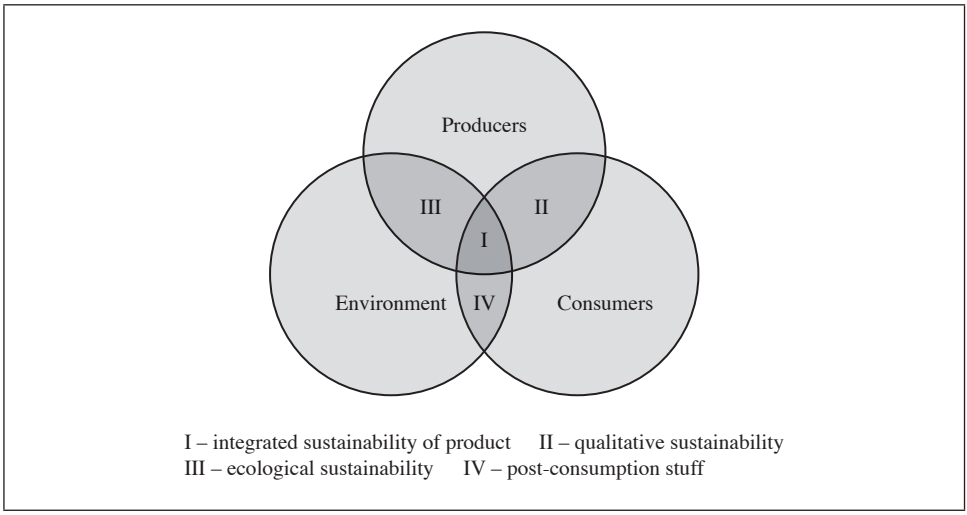


Fig. 1. Product Sustainability Model

Source: the authors.

In Figure 1, the highest degree of product sustainability is visible in area I, where saturation with added values comes from three factors: production, environmental impact and consumer awareness. This area includes products meeting the criteria of sustainable development and circular economy, integrating the balance between economic, social and environmental aspects.

The second area is qualitative sustainability, which is related to meeting customer needs through the functional features and quality of products. The Sustainable Products Initiative (SPI) assumes that to achieve the goals of a circular economy,

products should be designed with durability, energy efficiency, material savings, ease of repair and recycling in mind.

The third area includes ecological sustainability, which can be seen most noticeably on the sustainable products market, and is often marked with special certificates. Unfortunately, customers do not always recognise these labels. This can leave them confused and susceptible to greenwashing, and in need of education on their purchasing activities (Kozik, 2020).

The fourth area covers post-consumer processes after the end of the product life cycle. In this area, it is important to avoid creating "garbage" and focus on secondary raw materials. The results of the latest Global Sustainability Survey indicate that 75% of consumers consider environmental sustainability to be important when making purchasing decisions (Staniec, 2023). According to the results of other studies, the percentage is even higher, reaching 79% (Capgemini, 2020) or even 83% (Gul, 2022). Previous research on consumer awareness of sustainable development goals and sustainable behaviour is relatively limited and incomplete (Maciejewski, 2023). Trudel (2019) presents an important summary of research on sustainable consumer behaviour and the factors influencing such attitudes. Maciejewski (2020) examined the impact of the idea of sustainable development on the diversity of consumer behaviour. Zalega (2019), meanwhile, conducted research on attitudes towards sustainable development and sustainable behaviours among individuals from Generations Z and Y.

The subject literature also contains research results on awareness and knowledge of the Sustainable Development Goals (SDG) in various communities (Omisore *et al*., 2017; Smaniotto *et al*., 2020). Maciejewski (2023) notes that regardless of whether the research covers communities in developing countries or those belonging to the world's largest economies, effective promotion of the idea of sustainable development is necessary to achieve the adopted SDG goals by the 2030 deadline (UN, 2015). Other researchers also argue that social awareness in the rational management of unnecessary matter, acquiring pro-ecological habits, and the use of "economics of moderation" (Pach, Kowalska & Szyja, 2016) will be of key importance in the circular economy. Focusing purchases on sustainable products should help make achieving the goals set in the circular economy model a reality.

The aim of the present analysis was:

A: To identify consumer awareness and beliefs regarding sustainable products according to consumer profiles.

The following research problem was posed:

Q: Which formal characteristics of consumers differentiate their awareness and beliefs regarding sustainable products and what is the nature of this differentiation?

We opted to solve the problem using the quantitative approach.

## 2. Method

We posted a survey questionnaire on the website Ankieteo and used the CAWI method. The questionnaire was up from January 4 to 31, 2024. 570 correctly completed questionnaires were obtained and subjected to statistical processing. The sample is not representative, as it was not selected based on a sampling scheme. The survey questionnaire consisted of 24 items, where:

– items 1–5 concerned the formal characteristics of consumers,

– items 6–9 were designed to determine awareness and knowledge of the concepts of sustainable development, the circular economy, sustainable products and greenwashing,

– items 10–24 identified consumers' beliefs regarding sustainable products.

Selected variables were used in this analysis. Knowledge of concepts was measured on the basis of yes/no answers. Awareness was measured on a five-point scale, where 1 meant "definitely not" and 5 meant "definitely yes". A description of the variables is presented in Table 1.

Table 1. Description of Variables Used in Empirical Research

| Variable Number | Description of Variable |
|---|---|
| P1 | Respondent's gender |
| P2 | Respondent's age |
| P3 | Respondent's place of residence |
| P4 | Respondent's education |
| P5 | Assessment of the respondent's financial situation |
| P6 | Knowledge of the term "sustainable development" |
| P7 | Knowledge of the term "circular economy" |
| P8 | Knowledge of the term "sustainable product" |
| P9 | Knowledge of the term "greenwashing" |
| P10 | Treatment of consumer leftovers in the household |
| P11 | Indication whether the production of products affects climate change |
| P12 | Indication whether products should support eco-friendliness even at a higher price |
| P13 | Indication whether products should support fast fashion trends |
| P14 | Indication whether it is advisable to deliberately shorten the life of products |
| P15 | Indication whether the products should be highly durable |
| P16 | Indication whether products should be energy-efficient |
| P17 | Indication whether coal-based energy should be phased out in the production of products |
| P18 | Indication whether it is advisable to allow testing of products on animals to increase consumer safety |

Table 1 cnt'd

| Variable Number | Description of Variable |
|---|---|
| P19 | Indication whether, given the choice, the consumer would give up disposable and plastic packaging |
| P20 | Indication whether packaging should be biodegradable |
| P21 | Indication whether eco-labels should be displayed and popularised in commercial transactions |
| P22 | Indication whether the obligation to repair, maintain and dispose of products should remain with the manufacturer |
| P23 | Indication whether products should be climate-neutral and low emission |
| P24 | Indication whether sustainable products improve living and working conditions |

Source: the authors.

The results were prepared using statistical analysis, which included the differentiation tests: chi-square for structure indicators, Kruskal-Wallis ANOVA and Mann-Whitney U test for differences between means in groups. The chi-square test is performed to test the relationship between two nominal variables. It also examines the significance of differences in interest structures. The null hypothesis is that the variables are independent, and the alternative hypothesis is that they are not independent. The test is based on a comparison of the values (those obtained in the study) and theoretical values (calculated assuming that there is no relationship between the variables).

The Kruskal-Wallis test is the equivalent of one-way analysis of variance (ANOVA) where the distribution of variables deviates from the normal distribution. In this test, the null hypothesis is that the samples come from populations with the same distribution, while the alternative hypothesis states that they come from different distributions. The consequence of adopting the null hypothesis is that the levels of the factor being tested do not have a significant impact on the results observed. Similarly, the rejection of the null hypothesis results in the statement that the levels of the factor under study significantly affect the results. It is then said that a given factor differentiates the results. The Kruskal-Wallis test is appropriate when there are at least three grouping variable codes. Where there were only two, the Mann-Whitney U test was used. Here, the null hypothesis assumes equality of means for both study groups, with the alternative hypothesis stating that the means differ.

The Kruskal-Wallis ANOVA was used for variables having more than two codes (results shown in Tables 6, 8, 10, 12). When a variable had only two codes (results shown in Table 4) the Mann-Whitney U test was used. The level of significance for all of the tests was assumed to be $\alpha = 0.05$.

## 3. Structure of the Sample

The structure of the sample decomposed by control variables is shown in Table 2.

Table 2. Structure of the Sample

| Variable | Category | *n* | % |
|---|---|---|---|
| Sex | woman | 344 | 60.4 |
| | man | 226 | 39.6 |
| Age | up to 34 | 271 | 47.5 |
| | 35–54 | 192 | 33.6 |
| | 55 and over | 108 | 18.9 |
| Domicile | village or city up to 5k | 150 | 26.2 |
| | city from 5k to 50k | 159 | 27.8 |
| | city from 50k to 500k | 188 | 33.0 |
| | city over 500k | 74 | 13.0 |
| Education | basic | 47 | 8.3 |
| | medium | 316 | 55.3 |
| | higher | 208 | 36.4 |
| Assessment of financial situation | bad | 80 | 14.0 |
| | average | 363 | 63.7 |
| | all right | 127 | 22.3 |

Source: the authors.

Further analysis was carried out by examining the differences in the results in terms of consumer awareness and beliefs according to the five control variables included in Table 2.

## 4. Analysis of the Results

Due to the different response scales, differences were analysed separately for variables identifying awareness of concepts (P7 and P8) and variables measuring beliefs towards individual statements (P11–P24).

Table 3 shows the differences in the fractions of variables P7–P8 according to the respondents' gender.

Based on the analysis of the data in Table 3, it was found that men were more aware of the concepts for both variables. The respondent's gender is a factor that differentiates the knowledge of the concept of circular economy (P7), which is significantly greater for men. However, knowledge of the concept of a sustainable product (P8) is not statistically differentiated by gender, although the difference in fraction sizes is significant.

Table 3. Differentiation of the Fractions of P7–P8 Variables According to Respondents' Gender

| Variable | Value | Category (%) | | Sample (%) | *p*-value |
|---|---|---|---|---|---|
| | | woman | man | | |
| P7 | yes | 37 | 49 | 42 | 0.045* |
| | no | 63 | 51 | 58 | |
| P8 | yes | 57 | 64 | 59 | 0.093 |
| | no | 43 | 36 | 41 | |

Notes: * denotes statistical significance.

Source: the authors.

Table 4 shows the differences in the mean values of variables P11–P24 depending on the gender of the respondents.

Table 4. Differences in the Mean Values of Variables P11–P24 Depending on Respondents' Gender

| Variable | Category | | Total Average | *p*-value |
|---|---|---|---|---|
| | woman | man | | |
| P11 | 3.91 | 3.65 | 3.81 | 0.001* |
| P12 | 3.62 | 3.37 | 3.52 | 0.001* |
| P13 | 2.64 | 2.88 | 2.74 | 0.006* |
| P14 | 2.42 | 2.45 | 2.43 | 0.965 |
| P15 | 4.11 | 4.11 | 4.11 | 0.712 |
| P16 | 4.19 | 4.06 | 4.14 | 0.062 |
| P17 | 3.70 | 3.42 | 3.59 | 0.007* |
| P18 | 2.13 | 2.84 | 2.41 | 0.000* |
| P19 | 3.99 | 3.67 | 3.87 | 0.000* |
| P20 | 4.11 | 3.91 | 4.03 | 0.009* |
| P21 | 3.85 | 3.64 | 3.77 | 0.011* |
| P22 | 3.91 | 3.88 | 3.90 | 0.479 |
| P23 | 4.06 | 3.85 | 3.98 | 0.017* |
| P24 | 3.96 | 3.66 | 3.84 | 0.000* |

Notes: * denotes statistical significance.

Source: the authors.

Analysis of the data contained in Table 4 reveals that gender significantly differentiated the responses for 10 out of 14 variables. For all of them, the average response value (measuring agreement with a given statement, i.e. "level of belief")

was higher for women. Men returned higher mean response values for variables P13 and P18. However, their interpretation calls for the scale to be inverted, i.e. the higher the value, the lower the level of belief, as in the case of variable P14. Therefore, women turned out to be clearly more convinced of a product's sustainability and a circular economy for all variables.

Table 5 presents the differences in the fractions of variables P7–P8 according to respondents' age.

Table 5. Differentiation of the Fractions of P7–P8 Variables in Relation to Respondents' Age

| Variable | Value | Category (%) | | | Sample (%) | *p*-value |
|---|---|---|---|---|---|---|
| | | up to 34 | 35–54 | 55 or more | | |
| P7 | yes | 40 | 56 | 42 | 42 | 0.000* |
| | no | 60 | 44 | 58 | 58 | |
| P8 | yes | 57 | 60 | 64 | 59 | 0.093 |
| | no | 43 | 40 | 36 | 41 | |

Notes: * denotes statistical significance.

Source: the authors.

For variable P7, the age of the respondents clearly differentiates the response fractions: the largest number of respondents who know the term "circular economy" are in the middle age group, i.e. 35–54 years old. This differentiation is statistically significant at the assumed level. In turn, for variable P8, measuring knowledge of the term "sustainable product", this knowledge increases in subsequent age groups. However, the differences are too small to be considered statistically significant. For both variables, awareness of the terms under consideration is the lowest among the youngest respondents.

Table 6 shows the differences in the mean values of variables P11–P24 depending on the age of the persons examined.

Table 6. Differences in the Mean Values of Variables P11–P24 Depending on Respondents' Age

| Variable | Category | | | Total Average | *p*-value |
|---|---|---|---|---|---|
| | up to 34 | 35–54 | 55 or more | | |
| P11 | 3.80 | 3.83 | 3.77 | 3.81 | 0.707 |
| P12 | 3.52 | 3.54 | 3.47 | 3.52 | 0.737 |
| P13 | 2.69 | 2.81 | 2.75 | 2.74 | 0.384 |
| P14 | 2.43 | 2.51 | 2.89 | 2.43 | 0.309 |
| P15 | 4.07 | 4.14 | 4.13 | 4.11 | 0.586 |
| P16 | 4.02 | 4.22 | 4.17 | 4.14 | 0.226 |

Table 6 cnt'd

| Variable | Category | | | Total Average | *p*-value |
|---|---|---|---|---|---|
| | up to 34 | 35–54 | 55 or more | | |
| P17 | 3.58 | 3.56 | 3.64 | 3.59 | 0.878 |
| P18 | 2.37 | 2.32 | 2.69 | 2.41 | 0.018* |
| P19 | 3.81 | 3.93 | 3.91 | 3.87 | 0.520 |
| P20 | 3.96 | 4.08 | 4.13 | 4.03 | 0.271 |
| P21 | 3.75 | 3.80 | 3.74 | 3.77 | 0.732 |
| P22 | 3.79 | 4.01 | 3.96 | 3.90 | 0.021* |
| P23 | 3.91 | 4.01 | 4.10 | 3.98 | 0.161 |
| P24 | 3.83 | 3.90 | 3.77 | 3.84 | 0.461 |

Notes: * denotes statistical significance.

Source: the authors.

Analysis of the data in Table 6 shows that for only two variables, P18 and P22, can the observed differences in responses due to the age of respondents be considered significant. For variable P18 (which has a reverse interpretation of the scale), the respondents' belief increases with age. For variable P22, the level of belief is clearly lower in the first age group (up to 34 years) than in the other two. This characteristic relationship also occurs for five other variables (P15, P16, P19, P20, P23), although it is not statistically significant (for variable P14 the differentiation is the opposite, as the interpretation of its scale is reversed). Further, for as many as eight out of the 14 variables (P11, P12, P15, P16, P19, P21, P22, P24), the level of belief is highest in the intermediate age group (35–54 years). The P14 variable is not included here because its interpretation requires reversing the scale.

In general, the analysis of Tables 5 and 6 leads to the conclusion that both the awareness of the issues under consideration and the belief in specific problems are clearly the lowest in the youngest age group.

Table 7 shows the differences in the fractions of variables P7–P8 depending on the place of residence of the people subjected to the study.

The analysis of the data contained in Table 7 allows us to conclude that in the case of variable P7 (knowledge of the term "circular economy"), the differences between the factions are small and it is difficult to indicate any direction of the relationship. Therefore, the differences proved statistically insignificant. However, in the case of variable P8 (knowledge of the term "sustainable product"), the differences in fractions are large and statistically significant. In the largest cities (those with over 500k inhabitants) knowledge of "sustainabile product" is significantly higher than in the three other groups.

Table 7. Differentiation of the Fractions of P7–P8 Variables Depending on Respondents' Place of Residence

| Variable | Value | Category (%) | | | | Sample (%) | *p*-value |
|---|---|---|---|---|---|---|---|
| | | village or town up to 5k | city 5–50k | city 50–500k | city above 500k | | |
| P7 | yes | 41 | 45 | 38 | 45 | 42 | 0.096 |
| | no | 59 | 55 | 62 | 55 | 58 | |
| P8 | yes | 57 | 60 | 57 | 72 | 59 | 0.000* |
| | no | 43 | 40 | 43 | 28 | 41 | |

Notes: * denotes statistical significance.

Source: the authors.

Table 8 shows the differences in the fractions of variables P11–P24 depending on the place of residence of the people participating in the study.

Table 8. Differences in the Mean Values of Variables P11–P24 by Respondents' Place of Residence

| Variable | Category | | | | Total Average | *p*-value |
|---|---|---|---|---|---|---|
| | village or town up to 5k | city 5–50k | city 50–500k | city above 500k | | |
| P11 | 3.96 | 3.57 | 3.80 | 4.01 | 3.81 | 0.021* |
| P12 | 3.63 | 3.40 | 3.43 | 3.77 | 3.52 | 0.009* |
| P13 | 2.78 | 2.69 | 2.81 | 2.59 | 2.74 | 0.493 |
| P14 | 2.53 | 2.48 | 2.46 | 2.05 | 2.43 | 0.023* |
| P15 | 4.13 | 4.04 | 4.05 | 4.36 | 4.11 | 0.027* |
| P16 | 4.14 | 4.05 | 4.12 | 4.41 | 4.14 | 0.073 |
| P17 | 3.68 | 3.47 | 3.50 | 3.86 | 3.59 | 0.035* |
| P18 | 2.41 | 2.40 | 2.50 | 2.24 | 2.41 | 0.479 |
| P19 | 3.87 | 3.77 | 4.16 | 3.87 | 3.87 | 0.056 |
| P20 | 4.06 | 3.92 | 4.02 | 4.23 | 4.03 | 0.153 |
| P21 | 3.81 | 3.72 | 3.70 | 3.96 | 3.77 | 0.116 |
| P22 | 3.86 | 3.83 | 3.86 | 4.20 | 3.90 | 0.028* |
| P23 | 4.03 | 3.91 | 3.89 | 4.26 | 3.98 | 0.037* |
| P24 | 3.93 | 3.70 | 3.88 | 3.91 | 3.84 | 0.295 |

Notes: * denotes statistical significance.

Source: the authors.

Table 8 shows that for seven (P11, P12, P14, P15, P17, P22, P23) out of the 14 variables analysed, the differences found were statistically significant, though it is difficult to indicate a clear direction of the relationship. In the case of as many as eight variables (P11, P12, P15, P16, P17, P20, P21, P23), the inhabitants of the largest cities (over 500k inhabitants) are more convinced about these detailed issues, while inhabitants of villages and small (up to 5k) towns were, notably, the second most convinced. This conclusion is specific for five of these variables (P11, P12, P15, P17, P23). However, for variable P14 (with a reversed scale interpretation), an increase in respondents' beliefs clearly increased alongside the population size of the place of residence.

Table 9 presents the differences in the fractions of variables P7–P8 in relation to the respondents' education.

Table 9. Differentiation of the Fractions of P7–P8 Variables in Relation to Respondents' Education

| Variable | Value | Category (%) | | | Sample (%) | *p*-value |
|---|---|---|---|---|---|---|
| | | basic | medium | higher | | |
| P7 | yes | 40 | 38 | 48 | 42 | 0.018* |
| | no | 60 | 62 | 52 | 58 | |
| P8 | yes | 45 | 56 | 69 | 59 | 0.000* |
| | no | 55 | 44 | 31 | 41 | |

Notes: * denotes statistical significance.

Source: the authors.

The analysis of the data in Table 9 allows us to conclude that for both concepts the differences are statistically significant. The nature of the relationship is very clear: in groups with a higher level of education, the level of awareness of the terms under consideration is higher. For both concepts, the conclusions are worth considering.

Table 10 shows the differences in the mean values of variables P11–P24 in relation to the respondents' education.

Table 10. Differences in the Mean Values of Variables P11–P24 in Relation to Respondents' Education

| Variable | Category | | | Total Average | *p*-value |
|---|---|---|---|---|---|
| | basic | medium | higher | | |
| P11 | 3.32 | 3.75 | 4.00 | 3.81 | 0.001* |
| P12 | 3.39 | 3.49 | 3.59 | 3.52 | 0.320 |
| P13 | 2.93 | 2.78 | 2.63 | 2.74 | 0.109 |

Table 10 cnt'd

| Variable | Category | | | Total Average | *p*-value |
|---|---|---|---|---|---|
| | basic | medium | higher | | |
| P14 | 2.50 | 2.56 | 2.23 | 2.43 | 0.004* |
| P15 | 3.74 | 4.04 | 4.29 | 4.11 | 0.000* |
| P16 | 3.70 | 4.06 | 4.37 | 4.14 | 0.000* |
| P17 | 3.45 | 3.53 | 3.70 | 3.59 | 0.059 |
| P18 | 2.50 | 2.52 | 2.23 | 2.41 | 0.023 |
| P19 | 3.43 | 3.78 | 4.09 | 3.87 | 0.000* |
| P20 | 3.45 | 3.97 | 4.25 | 4.03 | 0.000* |
| P21 | 3.39 | 3.71 | 3.92 | 3.77 | 0.001* |
| P22 | 3.42 | 3.86 | 4.05 | 3.90 | 0.000* |
| P23 | 3.59 | 3.88 | 4.22 | 3.98 | 0.000* |
| P24 | 3.61 | 3.74 | 4.05 | 3.84 | 0.000* |

Notes: * denotes statistical significance.

Source: the authors.

Table 10 shows that for 10 variables the differences were statistically significant. Here, too, the nature of the differentiation is clear: those from groups with a higher level of education indicate a higher level of beliefs regarding specific issues. This relationship occurs for all variables, both those differentiated in a statistically significant way and those for which the results cannot be generalised.

Table 11 shows the differences in the fractions of variables P7–P8 in relation to the self-assessment of the financial situation of those surveyed.

Table 11. Differentiation of the Fractions of Variables P7–P8 in Relation to Respondents' Financial Situation

| Variable | Value | Category (%) | | | Sample (%) | *p*-value |
|---|---|---|---|---|---|---|
| | | bad | average | all right | | |
| P7 | yes | 38 | 40 | 49 | 42 | 0.009* |
| | no | 62 | 60 | 51 | 58 | |
| P8 | yes | 52 | 59 | 67 | 59 | 0.000* |
| | no | 48 | 41 | 33 | 41 | |

Notes: * denotes statistical significance.

Source: the authors.

The data in Table 11 show that for both circular economy (P7) and sustainable product (P8), there is a clear and statistically significant differentiation of fractions

in the context of the self-assessment of one's financial situation. People in a better financial situation are much more aware of the meaning of these terms.

Table 12 shows the differences in the mean values of variables P11–P24 in relation to the self-assessment of the financial situation of the study's participants.

Table 12. Differences in the Average Values of Variables P11–P24 in Relation to Respondents' Financial Situation

| Variable | Category | | | Total Average | *p*-value |
|---|---|---|---|---|---|
| | good | average | all right | | |
| P11 | 3.76 | 3.76 | 3.97 | 3.81 | 0.156 |
| P12 | 3.65 | 3.49 | 3.53 | 3.52 | 0.228 |
| P13 | 2.66 | 2.73 | 2.81 | 2.74 | 0.631 |
| P14 | 2.51 | 2.41 | 2.45 | 2.43 | 0.743 |
| P15 | 3.99 | 4.11 | 4.17 | 4.11 | 0.506 |
| P16 | 3.98 | 4.14 | 4.27 | 4.14 | 0.141 |
| P17 | 3.51 | 3.62 | 3.53 | 3.59 | 0.623 |
| P18 | 2.41 | 2.43 | 2.36 | 2.41 | 0.896 |
| P19 | 3.79 | 3.88 | 3.87 | 3.87 | 0.781 |
| P20 | 3.76 | 4.09 | 4.02 | 4.03 | 0.019* |
| P21 | 3.59 | 3.82 | 3.71 | 3.77 | 0.143 |
| P22 | 3.74 | 3.93 | 3.90 | 3.90 | 0.292 |
| P23 | 3.89 | 3.99 | 3.98 | 3.98 | 0.746 |
| P24 | 3.76 | 3.86 | 3.85 | 3.84 | 0.898 |

Notes: * denotes statistical significance.

Source: the authors.

Analysis of Table 12 shows that only for the P20 (packaging should be biodegradable) are the differences in the mean values of the variables statistically significant. The averages for people assessing their financial situation as average or good are significantly higher than for people assessing it as bad. In the case of four variables (P11, P12, P15, P16), the differentiation is weak (a higher self-assessment of the financial situation means a higher level of conviction on specific issues). However, this conclusion cannot be generalised. Interestingly, for eight variables (P14 – inverted scale, P17, P19, P20, P21, P22, P23, P24) the highest averages occurred in the group of people assessing their financial situation as average, and for variables P12 and P13 (the latter with reverse scale), the highest average pertained to those who saw their financial situation as bad.

## 5. Practical Implications and Discussion

Activities towards sustainable development are definitely having an increasingly significant impact on how enterprises are perceived and the purchasing decisions of consumers. Wide-scale information campaigns should therefore be perceived as the basis for actual action for a better tomorrow and creating an image that allows producers to win over consumers (Mazurek-Łopacińska & Sobocińska, 2010; Buechler & Lee, 2019; Vazquez *et al*., 2023).

Segmentation is a response to the heterogeneity of markets and is the basis for building modern marketing strategies (Wedel & Kamakura, 2002). It allows products, services and marketing strategies to be tailored to specific consumer groups (Vazquez *et al*., 2023). It therefore leads to better adaptation to consumer needs, while also helping companies better reach those consumers whose preferences have been taken into account when shaping marketing activities (Gurgul & Wtorek, 2024).

Segmentation also yields information about the differences that exist between consumers in relation to purchase motives, which result from their specific demographic, geographical, psychographic and behavioural characteristics (Smith, 1956). It leads to a more thorough understanding of consumer needs and their characteristics, and thus also to effective planning of marketing communication activities (Żakowska-Biemas, Gutkowska & Sajdakowska, 2013).

The present analysis may be used to suggest thematic areas and groups (profiles) of respondents to whom educational activities should be directed at various levels of education in the field of circular economy and sustainable development. The promotion of sustainable consumption should be implemented as early as possible. Educational and public institutions and other workplaces should set an example of pro-ecological behaviour and pro-ecological management (Szymoniuk, 2015). A range of researchers has emphasised the role education can play in this area (Kirchhoff, 2010; Sady, Żak & Rzepka, 2019; Watkins *et al*., 2021). Education creates the pillars of the civil society of the future (Biancardi, Colasante & D'Adamo, 2023). The results of other research (Vazquez *et al*., 2023) suggest that priority should be given to activities that increase consumer awareness of sustainable products. Researchers have also shown that an increase in consumer awareness leads to interest in products and, ultimately, their success on the market (Buechler & Lee, 2019). Consumer education on sustainable development and sustainable consumption is also a priority goal for the EU (Kobylińska & Zbierzchowska, 2011). The goals of this education and promotion include (Mazurek-Łopacińska & Sobocińska, 2010):

– encouraging people to make purchasing decisions that maximise quality and long-term usability,

– cultivating a healthy lifestyle,

– encouraging respect for nature and the environment,

– eliminating and segregating waste,
– encouraging people to save energy and water,
– popularising knowledge about environmental protection.

Manufacturers and distributors wishing to promote the sustainability of their products may also consider using the results of this study. Many recent research results support these conclusions (for example, Rypakova, Stefanikova & Moravcikova, 2015; Boyer, Hunka & Whalen, 2021; Franco Lucas *et al*., 2022; Gul, 2022; Sudirjo, 2023; Vazquez *et al*., 2023). A responsible consumer, guided by the principles of sustainable development, makes conscious consumer decisions (Jastrzębska, 2019).

## 6. Conclusions

By examining the diversity of consumers' awareness and beliefs, it was found that individual characteristics are predictors of the diversity of substantive variables. The conclusions include:

1. Education is the best predictor. Among people with a higher level of education, both the awareness of the concepts under consideration and beliefs about specific issues are higher.

2. The second most important predictor was gender. Women are clearly more convinced about the issues of sustainable products and circular economy, though they know these terms to a lesser extent.

3. Place of residence is the third most effective predictor. The level of belief in sustainable products is in many cases clearly the highest in two groups: residents of the largest cities and of villages and the smallest towns.

4. Age turned out to be a weak predictor of differentiation. The nature of the differentiation proves that the older people become, the more aware they are of the issues under analysis.

5. The self-assessment of one's financial situation is an equally weak predictor. Only a certain nature of differentiation is visible, according to which higher levels of beliefs are declared by respondents in a better financial situation. However, this conclusion is neither clear nor generalisable.

Overall, the study allowed us to understand the diversity of consumer beliefs regarding sustainable products according to formal characteristics, i.e. consumer profiles.

## 7. Research Limitations

This research has been limited by various methodological and practical factors. First, there is the test. While many took it, the study was carried out only using the CAWI method, so it is not entirely representative. Likewise, the number of

questionnaire items is quite limited. Moreover, the selection of variables for the questionnaire was discretionary.

## 8. Directions for Future Research

The results of the analysis provide a starting point for posing and solving further interesting problems. In particular, one could consider using multidimensional exploratory techniques – for example, classification trees and cluster analysis. We have previously done such analyses for consumers of electronic banking services (Lotko, 2018) and students of post-commodity fields of study (Lotko, Melski & Lotko, 2023). A number of studies have segmented consumers of sustainable products in this way (Rypakova, Stefanikova & Moravcikova, 2015; Boyer, Hunka, & Whalen, 2021).

### Authors' Contribution

The authors' individual contribution is as follows: Each contributed a fifth.

### Conflict of Interest

The authors declare no conflict of interest.

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# HRM Practices in Internationalised SMEs and Their Sales Growth under Different Environmental Conditions

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## ABSTRACT

**Objective:** This paper explores the patterns of human resource management (HRM) adopted by internationalised small and medium-sized enterprises (SMEs) and their business outcomes with respect to changing external contingencies. More specifically, it examines the link between HRM and sales growth under two different conditions: the relatively stable pre-pandemic period and the highly uncertain first year of the COVID-19 pandemic.
**Research Design & Methods:** Data stems from structured interviews with key decision-makers representing 200 Polish-based SMEs operating internationally. Methods of data analysis include *k*-means clustering, one-way and two-way mixed ANOVAs.
**Findings:** Cluster analysis revealed four distinctive patterns of HRM adopted by internationalised SMEs. The significant interaction effect suggests that with changing environmental conditions specific patterns of HRM adopted in these firms contributed to sales growth in different ways.
**Implications/Recommendations:** The study revealed that environmental shock can both dampen and enhance the contribution of HRM practices to sales growth in internationalised SMEs, depending on their initial mix and intensity of use.

**Contribution:** The study contributes to the development of a configurational perspective in HRM research within internationalised SMEs. It demonstrates that multiple pathways can lead to positive outcomes, although not all are equally effective, especially when exogenous factors change dramatically. Thus, it highlights the importance of the external environment in moderating the link between HRM and business performance in these firms.

**Article type:** original article.

**Keywords:** human resource management, COVID-19, small and medium-sized enterprises, internationalisation, sales growth.

**JEL Classification:** F23, L25, M16, M54.

## 1. Introduction

Small and medium-sized enterprises (SMEs), considered as entities with fewer than 250 employees, have been widely recognised as the backbone of non-financial economies. This especially applies to the European context where they are major job providers (employing around 64% of all people working in non-financial sectors in 2020; Eurostat, 2022) and contribute significantly to total value added (52% in 2020; Eurostat, 2022).

Compared to large companies, SMEs are much more dependent on environmental factors and vulnerable to external crises (Harney *et al*., 2022; Miklian & Hoelscher, 2022). The above aspects seem even more important for those enterprises whose activities go beyond their home markets. Unlike domestic entities, internationalised SMEs experience greater complexity stemming from geographical dispersion and market differentiation (Lobo *et al*., 2020). This also entails more diverse challenges arising from global crises such as the COVID-19 pandemic. Like other global players, these enterprises require resources and organisational capabilities which allow them to successfully respond to these challenges and return to their development trajectory (Miklian & Hoelscher, 2022). However, as prior studies suggest, SMEs tend to utilise different human resource management (HRM) practices to overcome such difficulties (Lai *et al*., 2016; Hoke *et al*., 2022), which can be explained, at least partially, by the disadvantages of being small.

Limited resources and external context dependency which characterise SMEs translate into the specificity of HRM in these entities, described as less formalised, reactive, based on the competencies of owners-managers and previous experience of the company, using relatively simple methods and centralised decision-making processes (Festing *et al*., 2017; Harney & Alkhalaf, 2021; Harney *et al*., 2022). Importantly, the empirical studies emphasise rather a positive role of HRM in achieving superior performance in domestic SMEs (Rauch & Hatak, 2016), which in turn is consistent with the resource-based view (Wernerfelt, 1984; Barney, 1991).

However, there is a paucity of empirical studies that would comprehensively capture HRM practices and their outcomes in SMEs operating internationally, despite the increasing interest in this issue observed in the media and among business associations (Dabić *et al*., 2020, p. 717). Unlike the multinationals, SMEs rarely enter foreign markets through direct investments, while their international activities usually take the form of export and/or inter-organisational collaboration (Kuivalainen *et al*., 2012; Audretsch & Guenther, 2023). These unique features of internationalised SMEs create a different context for HRM, and thus constrain the applicability of abundant findings from IHRM literature, which is focused on large MNCs (Mendy & Rahman, 2019; Dabić *et al*., 2020).

To reduce the above gap in the extant knowledge, this paper focuses on patterns of HRM practices adopted by SMEs operating internationally. These patterns are defined as distinctive combinations of four basic sets of HRM practices – originally developed by Lepak and Snell (2002) – built around commitment, collaboration, compliance, and productivity. Due to the environmental dependence of internationalised SMEs, their sensitivity to external crises, and the multitude of contexts affecting them differently, it seems rather unlikely that a universal "best practice" approach would work in all such enterprises. Therefore, this study is aimed at identifying the real combinations of HRM practices adopted by these companies and analyse their business outcomes in two periods that differed in terms of uncertainty and dynamism in their external environment. It covers two consecutive years, namely 2019, when the conditions for conducting business activities, including exports were relatively stable and favourable, and 2020, which brought a significant increase in uncertainty and posed new challenges for international market participants resulting from the outbreak of the pandemic. As aptly noted by Clampit *et al*. (2022, p. 404), "extreme levels of environmental disruption and uncertainty allow the COVID-19 pandemic to serve as a «stress test»". This "test" demonstrated how well small and medium businesses were prepared to cope with such a challenge, which reflects the state of their resources and organisational capabilities including HRM.

Regarding business outcomes in SMEs, this study focuses on changes in sales dynamics in these entities. This is due to several reasons. Firstly, sales growth in the context of SMEs is used as one of the basic measures of business outcomes (Messersmith & Wales, 2011), financial performance (Rauch & Hatak, 2016) and firm growth (Delmar & Wiklund, 2008; Temel & Forsman, 2022). Secondly, sales growth also serves as an indicator of the success in entrepreneurship research (Delmar & Wiklund, 2008, p. 437). Thirdly, in times of crisis, SMEs resort to redundancies to a lesser extent than large entities (Lai *et al*., 2016; Edvardsson & Durst, 2021), and due to limited financial resources, maintaining the sales dynamic may prove to be a greater challenge for them (Temel & Forsman, 2022, p. 1). Therefore, changes in sales dynamics in these entities seem to more accurately reflect their

actual condition and effective coping with the crisis than the second commonly used measure – employment growth (Delmar & Wiklund, 2008; Rauch & Hatak, 2016). Moreover, as found by Delmar and Wiklund (2008, p. 451), employment dynamics directly depend on the motivation of managers (e.g. avoiding layoffs due to previous and/or expected difficulties in hiring), while changes in sales result largely from the market situation and the adequacy of the company's response to the conditions in its environment, determined, among others, by its ability to adjust human resources). Based on the above gap and rationale, the study addresses the following research questions:

1. What patterns of HRM practices emerge in the context of internationalised SMEs?

2. Do these specific patterns translate into differences between their "users" in terms of sales growth?

3. Assuming that these differences exist, are they consistent regardless of changes in external conditions?

To answer the above questions, this study utilised the empirical data stemming from the randomly selected sample of 200 Polish-based SMEs that were active exporters in the European and/or global market.

## 2. Literature Review

The idea of valuable contribution of HRM to sustainable competitive advantage is emphasised in the resource-based view. It assumes that companies can compete successfully and continue their growth owing to their organisational capabilities to integrate and deploy valuable, rare, inimitable and non-substitutable resources, including those embedded in employees (Wernerfelt, 1984; Grant, 1991). Therefore, HRM can be also understood as an organisational capability contributing to a firm's performance. From a configuration perspective, this capability comes from a set of HRM practices rather than isolated solutions. In line with this view, Lepak and Snell (2002) distinguished four bundles of HRM practices: commitment-based, collaboration-based, productivity-based, and compliance-based.

The core theme of the commitment-based bundle is internal development manifesting in emphasis on skill-enhancing practices and other activities promoting long-term commitment and retention of employees, particularly knowledge workers (Lepak & Snell, 2002, p. 520). This involves, among others, hiring based on potential to learn, extensive use of flexible job descriptions, job rotation, and internal promotion, substantial investment in continuous training and developing firm-specific skills, encouraging learning at the workplace through appraisal and feedback information (Lepak & Snell, 2002; Morris, Snell & Lepak, 2005).

The collaboration-based bundle appreciates sharing information, mutual trust, and good interpersonal relationships that ensure the inflow of unique knowledge

from the outside. Consequently, HRM practices are aimed at supporting team-building, networking, knowledge-sharing, and joint efforts (Lepak & Snell, 2002; Morris, Snell & Lepak, 2005).

The main concern of the compliance-based set is to ensure as much alignment with job/task requirements as possible at the lowest cost (Lepak & Snell, 2002). The required compliance with the rules, standards and/or procedures is achieved through the detailed specification of the necessary skills, duration and expected results, combined with the limited scope of assigned tasks and minimum discretion of the jobholder.

Finally, the productivity-based bundle is aimed at attracting candidates with competences meeting the specific job requirements and capable of achieving the expected results in that job. It relies upon person-job fit recruitment based on various sources and selective hiring, adopting short-term orientation and focus on performance in employee appraisal, compensation and skills improvement (Lepak & Snell, 2002; Morris, Snell & Lepak, 2005).

The distinction between these configurations is based on the assumption that the diverse nature of human capital implies the use of different HRM practices within a company. Consequently, large employers utilise several configurations of these practices simultaneously, depending on the category of employees. However, in SMEs, a small number of employees (with a less rigid definition of tasks to perform) may translate into different ways of adopting and combining these sets of practices (e.g. flexible, situational, selective use of practices found in the configurations described above). Therefore, in this study, each of these configurations is considered as a set of practices addressed to core employees (current and future), reflecting the way of thinking about human capital in a small or medium-sized company in the context of its current and future situation/needs.

Referring to the contribution of HRM to sales growth, it is worth noting that in the 1950s, Penrose (1959) already claimed that the growth of an enterprise is determined by its capabilities to acquire, develop, and coordinate the bundle of resources, including those contained in people. This also applies to SMEs. Notwithstanding the common constraints of a limited resource base, SMEs are not a homogeneous group, which implies many ways to achieve superior performance and/or support their growth. More specifically, their growth can be boosted by various business strategies that, in general, follow the logic of cost leadership or differentiation (Lechner & Gudmundsson, 2014), or even a combination of these two (Parnell *et al*., 2012). These options translate into different HRM-related priorities or needs that are met by different configurations of practices.

An increase in sales may be simply a consequence of selling more products, even without changing their specification or quality. This, in turn, can be obtained by: 1) additional employment of people needed to increase the sales volume (job holders

provided by productivity-based HRM or temporary workers supported by the compliance-based HRM), 2) reducing defective work effects through rigorous adherence to procedures, maintaining standards (supported by the compliance-based HRM), 3) improving work efficiency (ensured by the productivity-based HRM). Furthermore, a company can increase its sales due to changes to the offer that generate higher value for customers. In this case, greater sales dynamics result from higher prices paid for new products or their improved/unique attributes (Bahadir, Bharadwaj & Parzen, 2009). The driving force of this growth and the source of increased value provided to its customers may be derived from the firm-specific competencies (a primary concern of the commitment-based set of HRM practices), knowledge sharing and team innovations (promoted by the collaboration-based HRM).

The aforementioned variety of growth options for SMEs implies that any of the four configurations of HRM practices can actually contribute to an increase in sales, hence what matters is the intensive usage of any combination of these practices (assuming that their choice has solid business reasons). However, given the scope of SME activities considered in this study, it should be emphasised that their expansion in international markets requires them to adopt more formal and complex HRM practices in order to successfully compete with large employers for high-value job candidates and retain talented employees (Festing *et al*., 2017; Dabić *et al*., 2020). This requirement can be met to a greater extent by companies that widely use HRM practices belonging to various configurations, especially those focused on productivity and commitment. Therefore, we might expect that those internationalised SMEs whose HRM pattern is characterised by higher utilisation of practices within various configurations will achieve higher sales growth than other firms.

Nevertheless, the above considerations have so far omitted the issue of the external crisis and its implications for HRM. Meanwhile, some studies (e.g. Ketkar & Sett, 2010; Hauff, Alewell & Hansen, 2014) clearly suggest that environmental conditions that vary, among others, in terms of turbulence and uncertainty, require appropriate responses from HR architectures. In other words, the same combinations of HRM practices under different external conditions can produce entirely different results. It is also argued that in the highly volatile environment, greater HR flexibility and adaptability to changes can be provided by HR architectures built around the commitment-based bundle of practices, through their focus on in-house knowledge development, wide task variety, and employee empowerment (Lepak, Takeuchi & Snell, 2003; Hansen, Güttel & Swart, 2019). However, in a more stable and predictable environment, more rigid HR architectures that prioritise productivity can contribute more to business outcomes by better matching permanent employees to well-defined tasks (Lepak, Takeuchi & Snell, 2003).

Hansen, Güttel and Swart (2019) propose that in a highly volatile environment the approaches to HRM that combine the commitment-based and collaboration-based HRM practices are more likely to succeed. They also claim that, in stable and moderately volatile conditions, an appropriate architecture includes compliance-based practices supplemented by productivity-based, and some elements of the collaborative--based set. Although the above stance has not yet received empirical support, the relevance of environmental factors in this context cannot be underestimated. This especially applies to "exogenous shock" caused by the pandemic situation (Miklian & Hoelscher, 2022), which has become a difficult test of the existing approaches to HRM in SMEs operating internationally in terms of the contribution to their performance and firm growth. It is worth noting that during previous economic crises, it was innovation that allowed small businesses to maintain growth or even increase their dynamics (Temel & Forsman, 2022). Importantly, when it comes to HRM practices, both sets – focused on commitment and collaboration – have been found to be factors that contribute significantly to business innovation (Zhou, Hong & Liu, 2013).

Prior research suggests that SMEs, contrary to large companies, seem less prone to benefit from flexibility in human resources. More specifically, they seldom use redundancies to overcome difficulties arising from external shocks or economic crises (Lai *et al*., 2016; Edvardsson & Durst, 2021) and seek less radical measures of cost cutting to survive (Hoke *et al*., 2022). This can be explained by prior efforts in recruiting employees, which discourage the loss of these investments and seeking new recruits again, when the situation improves.

Hence, one would reasonably anticipate that amidst abrupt and substantial deteriorations of exogenous conditions, such as those caused by the COVID-19 outbreak, enterprises that adopted HRM approaches emphasising enhanced flexibility in harnessing their internal knowledge resources – particularly those focused on employee commitment – may attain better results. On the other hand, in arduous business circumstances, approaches that prioritise current performance and efficiency may be more effective in supporting endeavours of companies aimed at sustaining their sound economic condition. Thus, two different HRM patterns can actually be considered as a potentially good choice for SMEs coping with the pandemic crisis, one emphasising the use of commitment-oriented practices and the other focusing more on ongoing productivity/efficiency.

## 3. Methodology

The study was conducted in Poland, and its respondents were key decision-makers from SMEs operating in international markets. SMEs were defined as independent businesses that employed between 10 and 249 individuals, aligning with the staff headcount criterion outlined in Recommendation 2003/361/EC, while international activities means exporting, mainly to other European countries.

During the COVID-19 pandemic, SMEs exhibited a fairly strong resilience to adverse conditions. This was substantiated by a relatively small decline in value added in 2020 compared to the previous year, as well as positive employment dynamics contrasting with the negative trends observed in larger firms (Eurostat, 2022). As for Poland, the state of epidemic lasted from March 20, 2020, until May 15, 2022. In the first year of the pandemic, there was a slowdown in the growth rate of sales revenue, with the least severe impact observed in small firms (0.1% decrease), while medium and large firms experienced a more significant decline (approx. 2%). Similar changes were observed in employment dynamics (PARP, 2022). Importantly, no differences were noted between exporters and non-exporting firms in this regard.

Data analysed in this paper cover the period from 2019 to 2021 and come from the research project supervised by the author[1]. The empirical material stems from structured interviews (CATI) conducted with key decision-makers (founders/CEOs/top executives) acting as single key informants representing Polish-based SMEs. The selection procedure, preceded by testing the questionnaire, consisted of two stages: 1) random selection of small and medium-sized exporting enterprises from the national database (Statistics Poland), 2) qualifying them for the study by telephone contact to apply two filtering questions. These questions were aimed to confirm that the company performs export activities and achieved at least the level of 25% FSTS. Out of 1,395 selected firms, 308 (22.1%) did not meet the above criteria, while 887 (63.6%) refused to participate in the survey. The final sample size was 200 with the overall response rate at 14.3%. Non-response bias was tested by comparing the differences in the responses between early and late respondents, i.e. first 20% and last 20% of the respondents. As no significant differences were observed in mean values (regarding age, size, export intensity, sales growth), non-response bias does not appear as a problem.

The research instrument, a structured questionnaire, was based on prior literature review, and contained items adapted from the prior empirical studies. As for the analysis of quantitative data, several methods (available in IBM SPSS version 29) were applied, including *k*-means cluster analysis; one-way and mixed two-way ANOVAs.

A cluster analysis was applied to identify patterns of HRM in the surveyed SMEs. At this stage, four variables informing about the degree sets of practices were used, i.e. HRM based on commitment, cooperation, compliance and productivity, served as clustering variables. Their measurement was based on 51 questionnaire items adopted from the study by Lepak and Snell (2002, pp. 527–528). Following their approach, these variables were operationalised as the additive indices of HRM

[1] A full presentation of this project, including the research design and empirical results, can be found in the monograph by Purgał-Popiela, Pauli, and Pocztowski (2023).

practices, where each index was calculated by taking the mean value of the items belonging to the given bundle (Lepak & Snell, 2002, p. 526). Importantly, instead of a 5-point scale, a 7-point Likert-type scale was introduced, as recommended by Finstad (2010). It was also necessary to adapt the original questionnaire items to the context of the study through the back translation procedure, which ensures their linguistic equivalence. Respondents were asked to assess practices addressed to core employees/job candidates that were adopted before the pandemic and consistently applied in their organisations. The creation of indices for individual bundles was preceded by an analysis of the reliability of the scales. For the commitment-based, the collaboration-based, and the productivity-based HRM, standardised Cronbach's alpha coefficients were well above the acceptable level, reaching 0.871, 0.812, 0.806, respectively, while for the compliance set, this level was slightly lower, yet still acceptable, and amounted to 0.663.

Following Messersmith and Wales (2011, p. 123), sales growth was used to measure business outcomes. This study actually included two indicators, one of which referred to the first year of the pandemic (sales growth in 2020 vs. 2019 = 100), and the other reflected the pre-pandemic period (sales growth in 2019 vs. 2018 = 100).

The measurement of all variables was based on data from one source, hence it was necessary to take measures to alleviate the problem of common method bias. Following recommendations by Podsakoff *et al.* (2003, pp. 897–898), all the procedural remedies related to the questionnaire were implemented, and the anonymity of respondents was guaranteed. As for the independent – dependent variables concerns, the methodological separation (variety of scales, and forms of responses required) of measurement was applied. Finally, Harman's one-factor test was used, resulting in 23.52% of all variance in the data explained by a single factor. Thus, the common method bias does not arise as a major issue in this study.

## 4. Results

The presentation of the findings begins with the results of cluster analysis and the characteristics of companies according to the identified categories. The discussion then turns to the results of mixed ANOVA used to examine the sales growth in these clusters over the two periods, thereby including the effect of the changing external circumstances.

Initially, the *k*-means clustering algorithm was applied to define three, four and five clusters, resulting in correct classification for 98.0%, 96.5% and 94.5% of all cases, respectively. However, only the outcomes concerning four clusters were considered in further analyses, as they simultaneously ensured the high level of properly classified cases, the sufficient size of each cluster that met the assumptions of other statistical tests, and $F$ statistics values significant at $p < 0.001$ for each

set of HRM practices. Table 1 provides information on overall differences between individual clusters. More specifically, it shows that HRM practices in clusters "Efficiency if anything" (EA) and "Everything matters" (EM) are the most distant from each other (above 3 standard deviations). A relatively large distance also separates clusters EA and "Efficiency first" (EF), as well as clusters "Bit of everything" (BE) and EM, which is of approximately 2 standard deviations. In other cases, the distances between individual clusters vary by around 1.5 standard deviations.

Table 1. Distances between Final Cluster Centers in Four-cluster Solutions

| Cluster | BE | EA | EF | EM |
|---|---|---|---|---|
| Bit of everything | – | 1.590 | 1.613 | 1.961 |
| Efficiency if anything | 1.590 | – | 2.145 | 3.231 |
| Efficiency first | 1.613 | 2.145 | – | 1.514 |
| Everything matters | 1.961 | 3.231 | 1.514 | – |

Source: the author.

Results of ANOVA and *post-hoc* tests (Table 2) provide a detailed picture of these clusters in terms of differences in using four sets of HRM practices and average use of these practices combined. This average utilisation value in the sample amounted to 4.88 on a 7-point scale. However, its levels in individual clusters differed significantly, starting from the lowest (4.01) in EA and then 4.73 in BE. An above-average level of using all HRM practices was recorded in the EF cluster – 4.99, while the highest was in EM – 5.66. As for the average utilisation of the considered sets of HRM practices, in the entire sample it hovered around 5. The lowest average value pertained to the commitment-oriented bundle, while the highest average value belonged to the productivity-based set. Interestingly, these two sets most strongly discriminated between clusters, as indicated by the highest values of $F$ statistics, 138.26 and 122.44, respectively. At the cluster level, the largest differences in mean values concerned the collaborative-based set, for which the lowest level was achieved in EA – 3.77, and the highest in EM – 5.7.

The "Bit of everything" (BE) cluster comprised 48 companies. This group stood out for its above-average and relatively balanced usage of all bundles of HRM practices, with ratings for commitment-based and collaboration-based packages notably higher than other groups of firms. This latter feature was also found in the cluster "Everything matters" (EM); however, in BE, the average utilisation levels for both commitment-based and collaboration-based sets were significantly lower than in EM.

53 companies belonging to the cluster "Efficiency if anything" (EA) adopted an HRM pattern characterised by moderately low utilisation of HRM practices focused

on commitment and collaboration, as well as an average level in the case of two other sets. In comparison to the other clusters, utilisation levels of HRM practices were significantly lower, except for the compliance-based set, where the level was similar to the corresponding value in the BE group.

Table 2. Group Means, Results of ANOVAs and *post-hoc* Tests in Four-cluster Solution

| Variable | Sample Mean | ANOVA *F* value | BE Mean | EA Mean | EF Mean | EM Mean |
|---|---|---|---|---|---|---|
| Commitment-based | 4.76 | 138.26 | $4.83_{c}$ | $3.82_{a}$ | $4.45_{b}$ | $5.67_{d}$ |
| Collaboration-based | 4.87 | 110.88 | $4.88_{b}$ | $3.77_{a}$ | $4.90_{b}$ | $5.79_{c}$ |
| Compliance-based | 4.96 | 62.59 | $4.30_{a}$ | $4.53_{a}$ | $5.59_{b}$ | $5.46_{b}$ |
| Productivity-based | 5.00 | 122.44 | $4.66_{b}$ | $4.19_{a}$ | 5.54c | $5.64_{c}$ |
| HRM practices in total | 4.88 | 255.90 | $4.73_{b}$ | $4.01_{a}$ | $4.99_{c}$ | $5.66_{d}$ |
| Number of cases | 200 | | 48 | 53 | 36 | 63 |
| % of total | 100.0 | | 24.0 | 26.5 | 18.0 | 31.5 |

Notes: Levene's tests confirmed that the assumption of the variance homogeneity in these clusters is met. Each subscript letter (i.e. a, b, c, d) denotes mean value in a given cluster which, at the 0.05 level, does not differ significantly from the values in other clusters in Tuckey *post-hoc* tests.

Source: the author.

The "Efficiency first" (EF) cluster consisted of 36 enterprises. The pattern of HRM used by these entities focused on achieving high efficiency through an emphasis on compliance and productivity. The utilisation level of these practices was above average (5.6 and 5.5, respectively) and significantly higher than in the BE and EA clusters. The application of the collaboration-focused bundle in this cluster did not deviate from the average level, while practices oriented towards commitment were at a lower level.

The "Everything matters" (EM) cluster was the largest in the sample, including 63 entities. The pattern of HRM in this group did not favour any specific set of practices, as the average levels of utilisation for each of them ranged between 5.5 and 5.8. Generally, this level was higher than the sample average. The unique feature of this cluster was significantly higher (than in other groups) average values of the indices related to collaboration- and commitment-based, exceeding 80% of the maximum scale value.

A mixed-ANOVA was carried out to check how individual patterns of HRM affect the change in sales growth. The first stage focused on the effects of time and a pattern of HRM, and the interaction between them. Then, the simple main effects of the considered factors were examined. Statistical tests confirmed the significance of the main effect for one factor, i.e. pattern of HRM ($F(3, 195) = 16.019$, $p < 0.001$) and the interaction effect ($F(3, 195) = 3.687$, $p = 0.013$), whereas the main effect

of time appeared insignificant ($F(1, 195) = 0.0002$, $p = 0.987$). It can be therefore concluded that the average sales growth in the sample did not change significantly over time, while the companies belonging to different clusters of HRM practices varied in this respect. However, the significant value of $F$ statistics for interaction effect means that with time specific patterns of HRM affect sales growth in different ways (more specifically, sales growth in the period before and during the pandemic changed in different ways in individual clusters).

Figure 1 illustrates this interaction effect along with the estimated marginal means of sales growth for clusters in the pre-pandemic and pandemic periods. Simple effects, which show the influences of one factor (i.e. pattern of HRM) at each level of the other factor (i.e. period of time for which the sales growth was measured), provide more precise information on the nature of the interaction between the considered factors. SMEs in the EM cluster reported the highest sales growth in both considered periods when compared to other groups. The lowest dynamics of sales was found in the "Efficiency if anything" cluster, where three out of four HRM bundles were applied at significantly lower levels when compared to the others. These findings support the RBV assumptions and prior research concerning the positive contribution of HRM to superior business performance in SMEs (Rauch & Hatak, 2016).

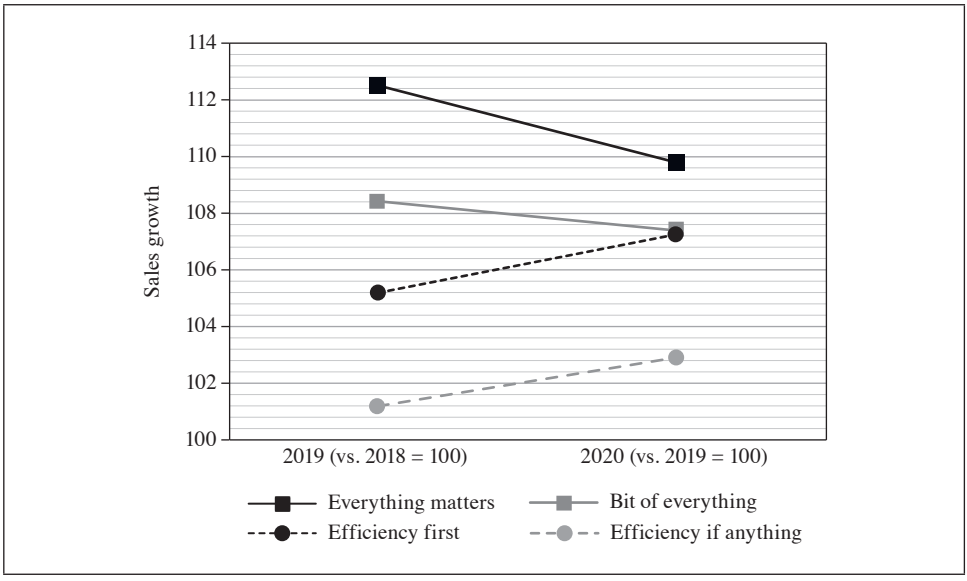


Fig. 1. Interaction Effect on Sales Growth in Clusters

Source: the author.

As Figure 1 demonstrates, before the pandemic differences in sales growth between clusters were generally greater than in the subsequent period. More precisely, during the pandemic the indices of sales growth tend to converge, most strongly in the case of the BE and EF clusters. Another important observation refers to directions of change. More specifically, two groups, namely "Efficiency if anything" and "Efficiency first" reported greater sales growth in this critical time, while the opposite effect was found in other clusters.

To examine the differences between these groups, additional tests (pairwise comparisons) were conducted. They confirmed that before the pandemic, indicators of sales growth were significantly higher in clusters EM and BE compared to EA (mean differences: 11.3 at $p < 0.001$ and 7.2 at $p = 0.002$, respectively), and in the EM cluster compared to EF (mean difference: 7.3 at $p = 0.002$). As for the next year, sales growth remained significantly higher in clusters EM and BE compared to EA, yet the mean differences were slightly smaller (6.9 at $p < 0.001$, and 4.4. at $p = 0.015$, respectively). Additionally, a significant difference (mean difference: 4.5 at $p = 0.022$) in this respect appeared between clusters EF and EA, while the significant difference between EM and EF reported in the previous year vanished (mean difference: 2.4, at $p = 0.601$). Finally, a significant negative change in sales growth (in 2020 compared to 2019) was found only in the EM cluster (mean difference: –2.7 at $p = 0.014$), whereas for other clusters no significant differences were found. Further comments regarding the above results are provided below.

## 5. Discussion

As this study has revealed, internationalised SMEs do not constitute a homogeneous group and therefore they adopt different approaches to HRM. Referring to the first research question, four patterns were found, of which two, namely "Everything matters" and "Bit of everything", represent more balanced combinations of HRM practices, and the other two, i.e. "Efficiency first" and "Efficiency if anything", favour certain sets of these practices. Furthermore, there are significant differences in the utilisation levels of individual HRM configurations between balanced and selective HRM patterns. They differ most in the presence of a commitment-based set of practices, which is consistent with the findings of Hauff, Alewell and Hansen (2014) on HRM clusters in German companies.

The second research question concerned implications of HRM patterns for the surveyed firms in terms of their sales growth. In both considered periods, there were significant differences in sales growth achieved by SMEs belonging to different clusters of HRM practices. Overall, patterns characterised by higher levels of HRM practices were associated with better business outcomes in both periods, though the differences between clusters converge during the pandemic. In the pre-pandemic year, significantly higher sales growth were recorded by SMEs with balanced

patterns of HRM, although the level of using these practices also mattered. More specifically, the greatest growth was achieved by SMEs whose HRM pattern was characterised by greater use of these practices. These findings are in line with the results of Rauch and Hatak (2016, p. 497), who found that a stronger presence of practices concerning employee commitment, participation and training was significantly associated with superior business performance, while selection, job description and compensation was either insignificant or weakly correlated with these outcomes.

This study also showed that in terms of average sales dynamics, the differences between the "Bit of everything" and "Efficiency first" clusters were insignificant, and during the pandemic they actually reached the same level – still higher than the cluster with a low level of practices (i.e. "Efficiency if anything"). This observation seems vital as these two different patterns of HRM turned out to be equivalent in terms of their corresponding business outcomes. Thus, it confirms the usefulness of the configuration theory emphasising "multiple ways to reach the same outcome" in understanding the role of HRM in SMEs (Kroon & Paauwe, 2022, p. 3227). On the other hand, what connects BE and EF clusters and at the same time strongly differentiates them from the EA cluster is a moderately high level of collaboration--oriented practices. This common component seems particularly important due to the specificity of SME internationalisation, which is largely based on formal and informal networks "compensating" for limited own resources (Dabić *et al*., 2020; Audretsch & Guenther, 2023).

As for the third research question, this study clearly demonstrates the importance of external factors for SMEs when investigating HRM practices and their contribution to sales growth. The interaction effect confirmed that under different circumstances individual patterns of HRM work differently. The sharp increase in uncertainty and difficulties in conducting business during the pandemic reduced the previous advantage of companies with more balanced HRM patterns, although more strongly in the EM cluster. Interestingly, in this period, SMEs that adopted selective patterns, i.e. focused on efficiency, achieved slightly higher sales dynamics than in the previous year. This may mean that, paradoxically, relatively more "frugal" patterns allowed them to react more quickly to current challenges. At the same time, the entities whose approach involved greater and continuous efforts to expand their own knowledge base, might have needed more time to adapt to changing conditions, which in turn could temporarily weaken the pace of growth. Another possible explanation may be the stronger impact of non-organisational factors during the pandemic period, including those related to the situation in foreign markets, which the surveyed companies experienced in different ways. Nevertheless, it is worth emphasising that despite the "suppressive" effect of the pandemic, differences in the

level of sales dynamics between companies with a low and relatively high level of various HRM practices persisted, in favour of the latter.

## 6. Conclusion

By examining various combinations of HRM practices in the context of internationalised SMEs, and considering the impact of external environmental factors, this study responds to calls for empirical research and relevant inquiries emerging from recent studies (Dabić *et al*., 2020; Harney & Alkhalaf, 2021; Kroon & Paauwe, 2022). It provides evidence supporting the applicability of the configuration approach in examining human resource management in SMEs, showing that there are multiple ways to achieve a positive outcome, although not all are equally effective, especially when the exogenous factors change dramatically.

The relevance of the findings for practice stems from several considerations. Firstly, this study provides a more comprehensive portrait of HRM in SMEs operating in foreign markets, emphasising the use of different configurations of HRM practices. Secondly, it highlights the issue of the diverse effects of individual patterns of HRM on business performance in terms of their total sales growth. Finally, this study provides a new insight into SMEs operating in times of turbulence and crisis.

The present study has some limitations. These include the homogeneity of companies in terms of country-of-origin, and selection criteria, which limit the general applicability of the findings. Moreover, quantitative research that focuses on the level of utilisation does not provide sufficient insight into the content of HRM practices. Furthermore, the retrospective character of the study, which allows for a more complete capture of ongoing HRM practices, creates difficulties in recalling events distant in time. Therefore, two directions for further research are proposed. First, large-scale studies are recommended to validate these findings and compare them in different institutional settings, and thus enhance their applicability. Regarding the second direction, multiple case studies seem worth considering because they enable us to capture the complexity of HRM practices in their natural context, and better understand their multifaceted contribution to the growth of the firm.

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### Conflict of Interest

The author declares no conflict of interest.

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# Robert Owen as an Undervalued Pioneer of Human Resource Management: Research Gap Based on State-of-the-art and Systematic Literature Reviews

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## ABSTRACT

**Objective:** The aim of the article is to diagnose whether there is a research gap in the work from the last two decades (on Robert Owen's achievements) related to Owen's contribution to the emergence of human resource management (HRM).

**Research Design & Methods:** I followed a state-of-the-art review (SotA) and a systematic literature review (SLR).

**Findings:** Robert Owen is widely recognised as a utopian socialist and/or one of the pioneers of management. He is also one of the first who underlined the importance of an organisation's human resources. Nevertheless, I noticed that researchers underestimate Owen's contribution to the development of human resource management, and their works do not devote much space to Owen's achievements related to this subdiscipline of management. The results of the reviews prove the interdisciplinarity and multicontextual nature of Owen's ideas, while highlighting the research gap related to his achievements in the field of HRM.

**Implications/Recommendations:** I suggest that studies on Owen should be carried out by HRM experts, as they know the details of this subdiscipline best. Even if business history knowledge does not play a crucial role in management practice, knowledge of the origin of management methods and techniques may help HR managers to correctly apply them in organisations.
**Contribution:** The article is one of the few (if not the only) in which texts devoted to Owen and his achievements in the field of HRM are analysed through SLR. It can be a source of inspiration for scientists, management teachers, and students who are looking for an insufficiently recognised research topic.

**Article type:** original article.

**Keywords:** Robert Owen, human resource management, research gap, state-of-the-art review, systematic literature review.

**JEL Classification:** B19, M12.

## 1. Introduction

It is well known that Robert Owen, born in Wales in 1771, was a utopian socialist, a social and political activist, an entrepreneur, and one of the precursors of management sciences. His works and achievements are interdisciplinary and have been analysed (and still are) by representatives of many scientific disciplines, including political scientists, historians, educators, and management specialists. In management studies, Owen is often referred to as a pioneer of cooperatives or city management (Donnachie, 2007; O'Hagan, 2008). His works to improve working conditions are considered revolutionary and have been included in the laws of many countries around the world. However, what is not always remembered, and what is important from the point of view of understanding modern management, is that Owen contributed much more to the development of management science and practice. Some of Owen's so-called social experiments (Hatcher, 2013), conducted in the early 19th century in the New Lanark in Scotland and the New Harmony in the USA, concerned human resource management (HRM). Owen was one of the first managers to recognise the importance of an organisation's human resources. He argued that bringing out and maintaining the best performance in current and future employees required constant care (Kaikai, 1989) and assumed that paying more attention to workers would pay off in increased output (Griffin, 2013, pp. 33–34). Although Owen is considered the precursor of human resource management (Davis, 1957; Dulebohn, Ferris & Stodd, 1995; Thakur, 2020), his achievements related to HRM have not received much attention in the literature, and his contribution to the development of HRM is not fully appreciated. To validate this statement, I decided to conduct research. The aim of my analysis was to check whether (in contemporary research on Owen's achievements) there is a research gap

related to Owen's contribution to the emergence and development of HRM, which can be filled with future studies. To achieve the aim, the study intends to respond to the four conceptual research questions:

RQ1: Which of Owen's achievements are the subject of research?

RQ2: Which scientific disciplines are interested in Owen's work?

RQ3: What has been written about Owen and his achievements in the context of social sciences (especially in the context of management)?

RQ4: Are Owen's achievements analysed from a HRM point of view?

To address these questions, data was collected following traditional and systematic literature reviews.

My analysis proceeds as follows. I begin by presenting the research methods. The second section, based on a state-of-the-art review (SotA), shows Owen's most important achievements. The next section contains the results of a systematic literature review (SLR). The article ends with a discussion (including answers to the research questions, limitations of the analysis, and directions for future research) and conclusions.

The article is not a historical study; it does not show data or examples that illustrate phenomena from the past. The article examines the current interest of researchers in Owen's achievements, i.e., it concerns the present. However, I hope that the text will motivate other researchers to analyse Owen's ideas related to HRM, that is to study the past. I hope that the results of my reviews will inspire not only sociologists and economists but, above all, representatives of management sciences, who will make an effort to accurately identify Owen's contribution to the development of human resource management and its tools. Consequently, the text encourages analysis in the (generally understood) field of business history, which is still rather poorly recognised by representatives of management sciences (Fridenson, 2008). But this is important because, despite being in the middle of a "historic turn" in the study of management (Clark & Rowlinson, 2004), the literature reviews I conducted have shown that human resource management researchers are not very interested in Owen's thoughts or achievements in the field of HRM. Consequently, there is still a research gap to be filled. It would be ideal if HRM scientists wanted to do so because deeper knowledge of the origins of HRM is needed for better understanding the very fast evolving practices of human resource management.

## 2. Research Design and Methods

To achieve the research goal (and answer the research questions), I used the literature review method. I chose two literature review techniques: 1) state-of-the-art/science review, and 2) systematic literature review. State-of-the-art reviews belong to the group of traditional (non-systematic) reviews. They may offer new perspectives on a problem or highlight areas that require further study (Grant & Booth, 2009),

and show what has and has not been investigated. It should be underlined that SotA reviews are valued by academia, but guidelines or specific methodology descriptions for researchers to follow when conducting this type of knowledge synthesis are conspicuously absent (Barry, Markebu & Varpio, 2022). Systematic reviews attempt to collate all evidence that fits prespecified eligibility criteria in order to answer a specific research question. Their aim is to minimise bias through transparent and systematic methods (Green *et al*., 2008; Chandler & Hopewell, 2013). Currently, representatives of various scientific disciplines (including management sciences) use systematic literature reviews. Scandura and Williams (2000, p. 1263) argue that "without rigor, relevance in management research cannot be claimed". I organised my research procedure (in the case of both the non-systematic and the systematic review) according to the SALSA model (Table 1).

Table 1. SotA and SLR according to SALSA Model

| Steps in the Review Process | Type of Review | |
|---|---|---|
| | SotA | SLR |
| Search | Aimed at a comprehensive search of current literature | Aims for an exhaustive, comprehensive search |
| Appraisal | No or limited formal quality assessment | Quality assessment can determine inclusion/exclusion |
| Synthesis | Typically narrative but may be accompanied by tables or graphics | Typically narrative with tabular accompaniment |
| Analysis | Current state of the research area on a topic and highlights future research topics; the most recent literature on a topic to provide evidence to support policymakers | What is known; recommendations for practice. What remains unknown; uncertainty around findings, recommendations for future research |

Source: (Booth, Sutton & Papaioannou, 2016, pp. 23–27).

For the non-systematic review, I used (mainly) the Google Scholar search engine; the search was conducted on 23 February 2023. The number of texts devoted to Owen (or referring to his achievements) amounted to over 47,000. So, I decided to narrow the search to texts that contain the exact phrase "Robert Owen" in the title (I wanted to be sure that the text is devoted to Owen and/or his achievements), and were published no earlier than 2000 (I wanted to focus on the latest studies on Owen). After narrowing the search, I identified 266 texts (Table 2). I have not adopted any formal criteria for evaluating the quality of selected texts; the evaluation was based on my research experience. I only analysed texts in English, which means that the number of texts was less than 266. The works found in Google Scholar are books, book chapters, scientific articles, and also popular science texts (some of them

were published on the Internet only). It is worth noting that in the SotA review, I did not find any previously published results of other systematic reviews of Owen's work.

Table 2. Narrowing SotA Search Results

| The Searched Phrase | The Location of the Searched Phrase | The Year of Publication | Number of Texts |
|---|---|---|---|
| "Robert Owen" | anywhere in the article | no date limits | 47,100 |
| | in the title of the article | no date limits | 860 |
| | in the title of the article | no earlier than 2000 | 266 |

Source: the author.

Table 3. Search Strategies in Scopus and Web of Science Databases

| Base | The Searched Phrase | Search within | Year Range | Subject Area | Full Text Available | Search Results |
|---|---|---|---|---|---|---|
| Scopus | "Robert Owen" | all fields | no year range | no subject area | no | 1,048 |
| | | article title, abstract, keywords | no year range | no subject area | no | 151 |
| | | article title | no year range | no subject area | no | 56 |
| | | article title | 2000–2023 | no subject area | no | 40 |
| | | article title | 2000–2023 | social sciences; business, management and accounting | no | 30 |
| | | article title | 2000–2023 | social sciences; business, management and accounting | yes | 13 |
| Web of Science | "Robert Owen" | all fields | no year range | no subject area | no | 271 |
| | | article title, abstract, keywords | no year range | no subject area | no | 148 |
| | | article title | no year range | no subject area | no | 87 |
| | | article title | 2000–2023 | no subject area | no | 66 |
| | | article title | 2000–2023 | social sciences; management | no | 7 |
| | | article title | 2000–2023 | social sciences; management | yes | 3 |

Source: the author.

Table 4. Texts Included in the Systematic Review

| Base | Authors | Year | Title | Document Type | Journal/Publisher | Country | Citations |
|---|---|---|---|---|---|---|---|
| Scopus | del Valle Alcalá, R. | 2021 | Class Antagonism and the Limits of Utopia in Matthew Lewis and Robert Owen | article | *Nineteenth-Century Contexts*, *43*(4), 465–477 | Sweden | 0 |
| | Drolet, M., & Frobert, L. | 2021 | Robert Owen and Continental Europe | article | *History of European Ideas*, *47*(2), 175–190 | UK, France | 0 |
| | Gioia, V., & Soliani, R. | 2021 | The Reception of Robert Owen's Thought in Nineteenth- and Twentieth--century Italy | article | *History of European Ideas*, *47*(2), 374–403 | Italy, Italy | 0 |
| | Kuligowski, P. | 2021 | From Rejection to Historicisation: The Reception of Robert Owen's Ideas in the Nineteenth-century Polish Context | article | *History of European Ideas*, *47*(2), 202–215 | Poland | 0 |
| | Doe, N. | 2019 | Robert Owen (1820–1902) | review | *Ecclesiastical Law Journal*, *21*(1), 54–68 | UK | 0 |
| | Trincado, E., & Santos--Redondo, M. | 2017 | *Economics, Entrepreneurship and Utopia: The Economics of Jeremy Bentham and Robert Owen* | book | Routledge | Spain, Spain | 3 |
| | Humphreys, J. *et al.* | 2016 | Disharmony in New Harmony: Insights from the Narcissistic Leadership of Robert Owen | article | *Journal of Management History*, *22*(2), 146–170 | US, US, US, US, US, US | 9 |
| | Leopold, D. | 2015 | Scientific Socialism: The Case of Robert Owen | book chapter | In: K. N. Demetriou, A. Loizides (Eds), *Scientific Statesmanship, Governance and the History of Political Philosophy* (pp. 193–209). Routledge | UK | 2 |

Table 4 cnt'd

| Base | Authors | Year | Title | Document Type | Journal/Publisher | Country | Citations |
|---|---|---|---|---|---|---|---|
| Scopus | Donnachie, I. | 2014 | People, Places and Spaces: Education in Robert Owen's New Society | book chapter | In: S. Mills, P. Kraftl (Eds), *Informal Education, Childhood and Youth* (pp. 81–96). Palgrave Macmillan | UK | 1 |
| | Davies, T. R. | 2014 | Educational Internationalism, Universal Human Rights, and International Organisation: International Relations in the Thought and Practice of Robert Owen | article | *Review of International Studies*, *40*(4), 729–751 | UK | 3 |
| | Hatcher, T. | 2013 | Robert Owen: A Historiographic Study of a Pioneer of Human Resource Development | article | *European Journal of Training and Development*, *37*(4), 414–431 | US | 7 |
| | Leopold, D. | 2013 | Education and Utopia: Robert Owen and Charles Fourier | book chapter | In: C. Brooke, E. Frazer (Eds), *Ideas of Education. Philosophy and Politics from Plato to Dewey* (pp. 178–193). Routledge | UK | 1 |
| | Harrison, J. | 2009 | *Robert Owen and the Owenites in Britain and America: The Quest for the New Moral World* | book | Routlege | US | 8 |
| Web of Science | Rogers, C. | 2018 | Utopian Socialism and Social Transformation | article | *Journal of the History of the Behavioral Sciences*, *54*(4), 256–271 | UK | 0 |

Source: the author.

The search (as part of a systematic review) was conducted on 25 February 2023 in the Scopus and Web of Science (WoS) databases, which are recommended for systematic reviews. The entire search process was documented in real time. I did not use any Boolean operators; I searched for the phrase "Robert Owen". A search (without any exclusion criteria) for "Robert Owen" returned 1,048 results in Scopus and 271 in WoS. For the systematic review (as in the case of the SotA), I adopted the following narrowing criteria: the phrase "Robert Owen" in the title of the text, and the paper was not published earlier than in 2000. Due to RQ3 and RQ4, I limited the search to the subject area "social sciences" and "business, management and accounting" (for the Scopus database), and "social sciences" and "management" (for WoS). Based on the exclusion criteria used, Scopus reduced the results to 30 papers. After excluding texts by Owen himself (selected works of Owen), as well as texts in languages other than English, and articles that could not be accessed, 13 publications were obtained (Table 3). There were three texts available in the WoS database. Two of them are repeats of the Scopus database. Therefore, only one work found in the WoS was included in the analysis (Table 3). As a result of the selection, 14 texts were examined further (Table 4).

## 3. Results of a Non-systematic Literature Review

In the literature, Robert Owen is shown not only as one of the most important thinkers of his era but also as a controversial figure of his generation (Donnachie, 2005). As Cole (2019) notes, the Owen who acquired the New Lanark Mills in 1799 and the Owen who purchased the Rappite community at New Harmony in 1825 appear to be two different persons. Humphreys *et al*. (2016) recognise Owen's narcissistic personality. Contemporaries call Owen an apostle of the new economic order, while in the 19th century, he was referred to as "Mr. Owen the Philanthropist" (Cole, 2019). Although Owen's ideas never attracted the widespread interest in continental Europe that they enjoyed in Britain, Ireland, and America (Johnson, 2007; Drolet & Frobert, 2021), Owen himself is considered a "personality", a celebrity of the time, and a political figure (Trincado & Santos-Redondo, 2017) known in the national and international arena (Donnachie, 2011). The New Lanark factory he managed was visited by many well-known figures at the time: abolitionist William Wilberforce, the future US president John Quincy Adams, economists and philosophers including Jeremy Bentham, James Mill, and Thomas Malthus (Witzel, 2003, p. 262). Despite Owen's popularity in the 19th century, no biography has been written that fully shows his achievements. The first studies on Owen referred selectively to various aspects of his life and were mainly based on his autobiography, first published in 1906. It has been reissued many times, the last one in 2018. There

is still no publication that presents the multifaceted life of this thinker (Harrison, 2009; Cole, 2019).

In texts found in Google Scholar, Owen is most often presented as a visionary socialist, a utopian socialist (e.g. Donnachie, 2005; Rogers, 2018), and even "the utopian prince" (Duncan, 2003). This term was given to him by his contemporaries, who, like Friedrich Engels, included him among the leading utopians. Owen is widely recognised as the father of British socialism (Siméon, 2012). This Welsh thinker is also referred to as a pioneer of the cooperative movement, a trade unionist, a communitarian, a reformer of 19th century British industry, a promoter of common education, a secularist, or even a spiritualist (Leopold, 2015).

Owen is best known to the historians who investigate Owen's activities for his original approach to the organisation of a socialist society. These views were based on the philosophical assumptions of enlightenment of rationalism, materialism, and even utilitarianism. Owen believed that human nature is shaped by social circumstances – it was Owen's newfound principle, what he called "the science of the influence of circumstance" (Jones, 2021). Owen's overriding idea was the community, which was one of the key elements of his thought. He developed the idea of community in the American period of his activity in New Harmony. Owen's activities in the field of education were related to the concept of community. He thought that a happy society could be achieved with proper education (O'Hagan, 2008). Education (as a subject of consideration) appeared in Owen's thoughts quite late, but currently, texts devoted to this trend constitute the largest number of publications about Owen and his achievements. In these texts, Owen is presented as a reformer of the education system and pedagogy and the creator of education as we know it today (Bloom, 2003). Owen's idea was that education should make people aware of what is good and what is to be punished. According to Owen, the process of education was supposed to lead to the disappearance of punishments and rewards. The result of this process was the discrimination between good and bad behaviour. "From the period following 1813–14, there are very few of Owen's writings which do not contain a substantial reference to the importance of education in forming citizens" (McLaren, 2000, p. 108). For Owen, the starting point in his considerations was individual happiness, which resulted directly from the happiness of the community (Davis & O'Hagan, 2014).

Other works referring to Owen's achievements are those dealing with cooperatives. This research was initiated in the 1990s by George Jacob Holyoake. Although Owen himself did not show much interest in cooperative worker initiatives (emerging as an expression of spontaneity), this scope of his thought is taken up in research on the cooperative movement in Britain and other countries (Bloy, 2018; Diamantopoulos, 2023; Kurimoto, 2023; Woodin, 2023).

Owen was also an entrepreneur "who became one of Britain's most successful business leaders during the Industrial Revolution" (Witzel, 2003, p. 258). He developed a factory in New Lanark and made it profitable. However, Owen was not only a businessman, but also (and perhaps above all) a great employer of his time. He decided to reorganise the company and to create an industrial community, it is a whole social system based on a productive unit. At the time he managed New Lanark's cotton mills, the complex included (among others): mills, an engine house, a mechanics workshop, spacious and well-designed workers' houses, vegetable gardens, an educational institute, a school, a nursery building, and a store. Owen assumed that investing in people is the best capital investment. First, Owen increased the level of efficiency of work: replaced old machines with new ones, reduced waste, and developed an appraisal system. He improved the working conditions of weavers (reduced the hours of work for adults from 17 to 10 hours a day). In addition, he provided people with accommodation in workers' houses for which they paid low rent, he offered meals for employees, and free medical care. Owen was the first employer in the world to run a nursery for employees' children. He also cared for older children: he prohibited the employment of children under the age of 10 and did not allow working children to go to work at night or during the first shift. In the morning, the children attended a school, which was called the Institute for the Formation of Character. Owen consciously improved the working conditions. Today, one would say that he cared about the wellness of employees. As Hatcher (2013) concludes, Owen, by investing in broadly understood employee development (including promoting safe working conditions and protecting the health of employees), was already, undertaking activities characteristic of contemporary human resource management in the 19th century, which makes him a pioneer of human resource development (HRD).

## 4. Results of a Systematic Literature Review

The papers selected for systematic review (Table 4) are both "white" and "1st tier gray" literature (Adams, Smart & Huff, 2017) – respectively: eight articles, five books (or chapters in books), one review. The journals in which selected texts have been published are: *History of European Ideas* (three articles), *Nineteenth-Century Contexts* (one article), *Journal of Management History* (one paper), *Review of International Studies* (one text), *European Journal of Training and Development* (one), *Ecclesiastical Law Journal* (one). The different aims and scopes of these journals indicate that Owen's activity and achievements are the subject of analyses of many scientific disciplines. The analysed texts were written by a total of 21 authors. Ten papers are single-author publications, three works are two-person texts, and one article was written by six authors. Fourteen authors represent European countries, seven authors come from the US. Half of the European researchers are British

(seven authors); the others represent the following countries: Italy (two researchers), Spain (two people), Sweden, France, and Poland. Only one research team (Drolet & Frobert, 2021) is international. The British are the authors (or co-authors) of seven texts selected for SLR (three articles, three book chapters, and a review); Americans wrote two texts (one scientific article and a book). The discipline and/or scientific specialisation represented by one of the authors could not be identified. Other authors represent the humanities (nine people) and social sciences (eleven authors). The humanists are historians (eight researchers) and one researcher who represents literary studies (English literature). The representatives of social sciences are management specialists (five people), political sciences and international relations specialists (four authors), economists (one author), and psychologists (one).

The first of the selected texts appeared in 2009. In the following years, there were either no texts about Owen, or their number did not exceed two per year. The exception is the year 2021, from which four selected texts about Owen's ideas come, and three of them were published in one (dedicated to Owen) issue *47*(2) of the *History of European Ideas* journal. Overall: the number of publications on Owen and his achievements (positioned as social science texts) remains at a fairly low level (Fig. 1).

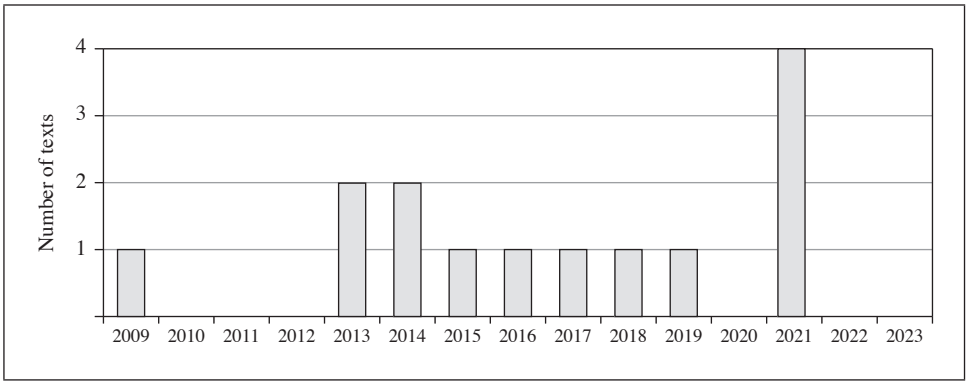


Fig. 1. The Year of Publication of the Texts Selected for SLR
Source: the author.

The selected works were quoted a total of 34 times (Table 4); the average number of citations per publication is 2.4. The leading, most often cited work (nine citations) is the article "Disharmony in New Harmony: Insights from the Narcissistic Leadership of Robert Owen". Six papers from the researched collection have not been cited at all. The reason for this may be that the writings are relatively new. It can also be assumed that Owen's achievements are not of great interest to researchers in the fields of social science.

Six of the chosen texts were given keywords. The results of keyword frequency analysis are not surprising. The most frequent keywords (or rather families/groups of keywords) are: Robert Owen/Owen/Owenism (five keywords), socialism/socialist(s) (four keywords), and utopianism/utopian (three keywords). The next six keywords are related to management: management history, management, leadership, narcissistic leadership, charisma, and human resource development. Only one keyword (the last one listed) refers directly to Owen's contribution to the development of human resource management.

Table 5. Research Perspectives in Selected Texts

| Authors | Year | Research Perspectives | | | | |
|---|---|---|---|---|---|---|
| | | Education | Political science and/or international relations | Economics and/or management | Law | Psychology |
| del Valle Alcalá, R. | 2021 | ✓ | ✓ | | | |
| Drolet, M., & Frobert, L. | 2021 | | ✓ | ✓ | | |
| Gioia, V., & Soliani, R. | 2021 | ✓ | | | | |
| Kuligowski, P. | 2021 | | ✓ | | | |
| Doe, N. | 2019 | | | | ✓ | |
| Rogers, C. | 2018 | | ✓ | | | |
| Trincado, E., & Santos--Redondo, M. | 2017 | | | ✓ | | |
| Humphreys, J. H. *et al*. | 2016 | | | ✓ | | ✓ |
| Leopold, D. | 2015 | | ✓ | | | |
| Donnachie, I. | 2014 | ✓ | | | | |
| Davies, T. R. | 2014 | ✓ | ✓ | | | |
| Hatcher, T. | 2013 | ✓ | | ✓ | | |
| Leopold, D. | 2013 | ✓ | | | | |
| Harrison, J. | 2009 | ✓ | ✓ | ✓ | | |

Source: the author.

The selected texts are heterogeneous. However, the review made it possible to distinguish three research perspectives most often used by the authors, which are: education (seven texts), political science and/or international relations[1] (seven texts), economics and/or management (five writings). Additionally: one text that focuses on legal issues presents Owen as a co-contributor to canon law; in another text,

[1] This perspective also includes considerations related to the idea of utopian socialism.

one can find threads in the field of psychology (Owen as a person with a narcissistic personality). In some writings, Owen's achievements are considered in several contexts. For example, Harrison (2009) explores various aspects of Owen's activity as activities for the development of education, implementing changes in (factory) management, and philanthropy (Table 5).

It is worth underlining (which is important from the point of view of the purpose of the study) that economic and management threads appear systematically in works devoted to Owen – they can be found in texts from 2009, 2013, 2016, 2017 and 2021. And even more important, there are direct references to human resource management in two texts (Hatcher, 2013; Trincado & Santos-Redondo, 2017). In the first of the aforementioned articles, Hatcher (2013) emphasises Owen's contribution to the promotion of employer activities in the field of human resource development and the creation of safe and hygienic working conditions. In turn, Trincado and Santos-Redondo (2017) call Owen "the father of personnel management" and present him as a management innovator who implemented the idea of well-being into organisational practice (e.g. by reducing the monotony of performed tasks, stimulating employees' creativity, and empowerment). In the articles and books analysed, there are some texts in which the word "management" cannot be found.

The research problems found in selected articles and books (or book chapters) demonstrate the interdisciplinarity of Owen's work. It also shows that Owen's achievements in human resource management are poorly covered in the scientific literature.

## 5. Discussion

My literature reviews indicate that Owen's views are interpreted differently in contemporary literature. A large part of the publications devoted to Owen, to introduce an analysis of his ideas and show the factors that influenced his work, describe (in greater or lesser detail) his biography or at least the most important events in his life. In answer to the first research question (RQ1: Which of Owen's achievements are the subject of research?), it should be noted that Owen's contribution to the development of the socialist/workers' movement is the most popular subject of articles and books about him. The researchers focus on Owen's (broadly understood) social activities, that is, his achievements related to improving working conditions, the development of cooperatives, and the introduction of education. Some of the texts I analysed dealt with economic issues. Their authors highlighted that Owen, who managed the New Lanark factory, achieved what one would call market success today. Both literature reviews also confirmed that Owen was not only an excellent manager and leader, a utopian socialist, an advocate for education of children and adults, and a religious thinker. The reviews showed that Owen was also a person

who was in the midst of the "big" political questions of his time and had the power to influence the law.

Referring to the second research question (RQ2: Which scientific disciplines are interested in Owen's work?), it should be noted that the wide range of Owen's thinking made his ideas and achievements interesting to researchers representing both the humanities and the social sciences. This socio-humanist perspective on Owen's achievements reflects one of his basic assumptions that concern the human person as a social being. Among the humanists who currently write about Owen are historians (historians of thought, industrial historians, historical geographers), philosophers, scholars of religious studies, and researchers in English literature. Social scientists, on the other hand, are representatives of the political sciences and international relations, educators, psychologists, lawyers, economists, and management experts. It is worth repeating here, as has already been mentioned in describing the SLR results, that there are few publications about Owen that have appeared since 2000 and which can be found in Scopus or Web of Science databases as social science texts.

In response to the third question (RQ3: What is written about Owen and his achievements in the context of social sciences?), it is important to point out that representatives of the social sciences (like humanists) analysing Owen's work focus on three main themes: 1) utopian socialism, 2) education, and 3) management. However, those who study Owen's ideas and achievements from a management point of view, while highlighting his contribution to improving working conditions and the foundations he laid for today's understanding of the wellness of employees, marginalise Owen's "relationship" with other aspects of modern human resource management.

Among the investigated works, there are only two texts (Hatcher, 2013; Trincado & Santos-Redondo, 2017), in which Owen's activities are "close" to terms such as "personnel management" or "human resource management". Incidentally, although this is not the purpose of this study, I want to emphasise that Owen is rarely mentioned as a pioneer of HRM in the Polish literature (the author of the article comes from Poland). In the Polish management literature, Owen is usually called the father of cooperatives or a pioneer of city management. Although some Polish researchers recognise Owen as the precursor of human resource management, in the HRM literature, his achievements do not receive much attention, thus not fully appreciating his contribution to the development of this subdiscipline. This can be confirmed by Google search results. For a query (in Polish) about "Robert Owen and human resource management", only one result is obtained (Rogowska, 2018). This is an article published in a Polish-language journal in which, similarly to the work of Hatcher (2013), Owen is presented as a pioneer in investing in human resources. Considering the above, and answering the last research question (RQ4),

it should be concluded that Owen's works are not currently widely analysed by HRM researchers and/or practitioners.

Although my research is one of the few (or even the only) to use a systematic literature review to analyse texts devoted to Owen's achievements in HRM, it has limitations. SotA, as a non-systematic review, is burdened with researcher bias. I also acknowledge that I did not include sources other than Google Scholar in the SotA review, which restricted my analysis. In terms of the systematic review, the issue is that, in the text search stage, I limited the search to the phrase "Robert Owen" and abandoned the use of other combinations of words, which weakened the search effect. It is also worth recalling the difficulties with accessing the full content of the searched texts. In addition, both reviews included texts classified as "grey literature". Proponents of purism in research may therefore call my systematic literature review a multivocal literature review, which uses as input not only academic peer-reviewed papers, but also additional sources of knowledge, such as web pages (Patton, 1991).

Based on preliminary archival research, I noticed that some of the solutions Owen used two hundred years ago are practices that are currently recognised as the "new", "contemporary", or "in statu nascendi" HRM toolkit. Examples include the employment of the poor, vagabonds and beggars, which can be called inclusive management or inclusive leadership; the conscious improvement of working conditions, which is currently an element of work humanisation or health promotion, or, more broadly, the support of employee well-being; the provision of cultural entertainment and management libraries to employees, which today fall into the field of artistic intervention in the workplace. Hence, I intend to analyse Owen's achievements in terms of modern solutions used in human resource management. I am particularly interested in which of Owen's social experiments (considered utopian in the early 19th century) are being implemented today as human resource management policies, programmes, practices, or processes that use methods and techniques to put HRM strategic plans into effect. I can say that my next research purpose will be to check whether Owen was one hundred or even two hundred years ahead of his times in the field of HRM, and whether he should be called "the father" of the tools of contemporary human resource management.

The results of the analysis of Owen's achievements from the point of view of his contributions to the development of HRM should be of interest to management teachers and social science students. The recognition and description of Owen's management methods should also inspire management practitioners. Focusing on the analysis of Owen's activities in the field of HRM is also important from the point of view of managers who face the rapid development of HRM. In addition to the recruitment, development, appraisal, and remuneration techniques, the HRM toolkit also includes many other methods (e.g. promoting wellness, work-life balance,

or diversity). Although HRM instruments are the subject of scientific considerations, many of these considerations focus more on the external conditions that "forced" the creation of new methods, and not on their creators or pioneering implementations. In management sciences, and especially in HRM, little is said about the origins of this subdiscipline, its precursors, and the impact of their ideas on current HRM trends. The origins of HRM are limited to short descriptions of the achievements of the most important researchers; however, due to the dynamic development of HRM in the 20th century, the evolution of approaches to HRM has often been analysed since then. Even in one of the most popular HRM textbooks (*Armstrong's Handbook of Human Resource Management Practice*), the origins of HRM began in the 1940s (Armstrong & Taylor, 2014, p. 4). Therefore, although Owen is sometimes called "the father of HRM" (as already pointed out), his achievements are not thoroughly presented and discussed in the HRM literature.

Finally, I want to emphasise that I believe that studying the history of organisational thought is necessary to better understand the present. Thus, I share the opinion of Wren (1987), who claims that "through the study of the evolution of management thought, modern managers and students of management can be better equipped to face a changing world. History distills for us the lessons of the past and allows us to progress from where we have been to where we need to go" (Wren, 1987, p. 339). Consequently, as postulated by business history researchers (Jones & Zeitlin, 2008), I intend to use various methods and sources of research, i.e., I plan to use triangulation of methods and sources, to analyse (also critically) Owen's achievements, which formed contemporary thinking about the organisation and its human capital.

## 6. Conclusions

The results of reviews allow to conclude that there is a research gap related to Owen's contribution to the emergence and development of human resource management that can (and should) be addressed in future research. My conclusion is partially confirmed by Sirůček (2015), who claims that Owen is a half-forgotten personality in economic thought. Thus, the words of Kaikai (1989) still seem valid, according to which Owen's dedication to the development of collaboration in work environments and in governance may often be overlooked. It is a pity because all visitors to the restored New Lanark must be impressed by what Owen managed to achieve at the beginning of the 19th century. The local factory, houses for workers, school, walking paths, all these things are inspiring even today.

### Conflict of Interest

The author declares no conflict of interest.

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# Implications of Remote Working for Employees in the IT Services Sector: Experience of Polish Employees and Managers

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## ABSTRACT

**Objective:** Analysis of long-term implications of remote working for employees in the IT services sector from the perspective of Polish managers and employees. The aim of the research undertaken in this article is to identify various threats that result from the implementation of remote work in organisations.

**Research Design & Methods:** The theoretical part presents the issue of remote working, taking into account the challenges of its implementation, at different levels and in different dimensions (organisational, managerial, social). The empirical part presents the findings of the research carried out on a group of employees in the IT services sector and on a group of managers responsible for recruitment and management of work within IT project teams.

**Findings:** The findings show a number of negative consequences in terms of efficiency, effectiveness of task performance, trust building and, above all, exchange of knowledge and broadly understood learning among employees, which will lead to the worsening of problems with recruiting new IT staff in Poland in the long term.

**Implications/Recommendations:** Remote work will generate many new problems in the IT services sector.

**Contribution:** The article fills a gap in the literature regarding remote working in the IT services sector, which is the youngest, but at the same time the most rapidly developing sector in Poland, showing a tendency for further intensive growth.

**Article type:** original article.

**Keywords:** remote working, dispersed team, IT project management, job performance, home office, homeworking.

**JEL Classification:** M510, M540.

## 1. Introduction

Remote working in the IT services sector is nothing new, but the way it is implemented today and the reasons why it has become even more common among employees in this sector significantly affect organisational behaviour, motivation, commitment, building a culture of collaboration, knowledge exchange and, consequently, also loyalty, trust and relationships that the employee develops within the organisation (Taboroši & Strukan *et al*., 2020, pp. 52–59). Ultimately, the way it is implemented often determines whether the business goals of an organisation will be achieved at all, at what cost, with what effort, how long it will take, and what shape the team working together in this model will take. As work environments, social and technological trends change, so does the way we work. Today, employees of various organisations enjoy more freedom and flexibility than ever before (Eriksson & Petrosian, 2020, p. 4).

Remote work in the literature is also referred to as home office or homeworking and, as Mitrus (2020, p. 4) points out, similarly to telework, it is work organised using modern technologies. In the author's opinion, home office is established practice but requires agreement between the employee and the employer. It also reflects the realities of a given organisation and is the result of the needs of both stakeholders – the employee and the employer. It may affect the attractiveness of the employer among employees looking for employment.

Analysis of the literature on the subject indicates that researchers are interested in the impact of remote work on the efficiency and quality of team work. Sobczak (2021, p. 149) emphasises that the COVID-19 pandemic and the resulting increase in the number of employees who work in this model has enabled the implementation of in-depth research on the essence of remote work, including the identification of its positive and negative aspects for both employees and the organisations themselves. The, often forced, need to work remotely has exposed a number of problems that are associated with this work model and affect not only the way work is struc-

tured in organisations, but also have social and psychological consequences for the employees themselves. As Moczydłowska (2021, p. 22) points out on the basis of her research, remote work may generate many significant threats. In the perception of the surveyed managers, these included: loneliness of employees, a lack of connection to the company, poor team integration, difficulties in controlling employees, obstacles to communication, difficulties with employee motivation, barriers to assessing employee effectiveness, challenges for employee development, difficulty with access to data and knowledge, depression among employees, low quality of tasks performed, low employee independence, low employee creativity, delays in delivering work results, and others. The analysis of the current state of knowledge and research in the field of remote work in organisations allowed for the identification of a cognitive gap resulting from the deficit of studies that would indicate particularly significant threats resulting from the implementation of this model of work, especially in the perception of managers responsible for organising the effective work of teams in enterprises, taking into account the long-term perspective. In turn, the application gap refers to building awareness among management staff regarding the effects and possibilities of shaping remote work in a way that enables the achievement of established business goals. There is a noticeable shortage of studies that would provide recommendations for health care practice, indicating which threats should be of particular concern and what impact they may have on the condition of the entire team.

The aim of the research undertaken in this work is to identify various threats that arise from the implementation of remote work in organisations. Therefore, the following research questions were asked in the presented article:

1. How does remote working affect the efficiency of task performance, team collaboration and personal relationships within project teams among IT services sector employees?

2. What opportunities and constraints as regards knowledge exchange and trust building are generated by remote working?

3. What social, psychological, organisational and developmental consequences, if any, will remote working have among employees in the IT services sector in the long term, as assessed by managers?

## 2. Literature Review

To a large extent the methods of managing remote working determine not only the quality and efficiency of the work, but also whether a culture of collaboration will develop in the organisation, at what level knowledge can be exchanged and, consequently, what level of management will be reached, and to what extent business objectives will be met. There is another important aspect – in the era of the employee's market and a deep crisis in social relations, the question arises: Which

employees will base their professional lives only on remote working, abandoning other models of cooperation with organisations? How will this affect their needs, expectations, perception of collaboration and relationships with other people in the long term? What implications will this have for organisations themselves? Won't siloed working, characterised by mutual distance at various levels, be the beginning of the white bear[1] era?

Remote working is a way of carrying out work with great flexibility in terms of the place at which it is carried out and often the time within which tasks are actually performed (Jung, 2016, p. 84). Sokolic (2022, p. 202) points out that it is technological development that enables new ways of working to be introduced, but at the same time this makes it necessary to rethink the meaning of the size and composition of the organisation. In the author's opinion, the development of information and communication technologies and digitalisation have enabled the practice of working at a physical distance from the employer's premises which has resulted in a blurring of the physical dimension of an organisation. But since dimensions of an organisation are interrelated, changes in one dimension lead to changes in other dimensions of the organisation as well. Research analyses carried out by Ferrara *et al*. (2022, pp. 8–9) show that the amount of funds organisations will be willing to invest in the conditions and outcomes of remote working will largely depend on the culture of the organisation, which affects both strategic and human resources (work-life balance, flexibility, transparency, methods and criteria for assessing an employee's contribution). Remote working is likely to be successful when it matches the current value systems of an organisation, so in this respect, knowledge creation and sharing are crucial to promoting effective and successful remote working. The higher the consensus on the tools, dynamics and processes embedded in remote working, the more probable that employees will not experience a lack of support and role conflict when working outside the office.

In business practice, remote working, in order to remain efficient, most often requires development of new ways and methods of building and, above all, maintaining mutual relationships between the employee and the manager, the employee and other employees, the employee and the organisation, new channels and ways of exchanging knowledge, building commitment, assessment of efficiency and supervision of the work of its individual members. This form of working, apart from strictly tangible, financial and organisational costs, also entails major changes in the way an employee performs at various levels (Kardaszewicz, 2011, p. 58; McTaggart & McLaughlin, 2020, pp. 2–11; Al-Rfou, 2021, pp. 95–96; Kowalski & Ślebarska, 2022, pp. 7–9). This is also pointed out by Professor N. Bloom (Bloom *et al*., 2015, pp. 165–218) from Stanford University, one of the leading researchers on remote

[1] For the author, white bears mean white-collar employees who carry out their work mainly alone, with minimal support from the manager and the team.

working – depression and boredom is a state that remote employees sink into very easily. An experiment conducted by the professor on a group of 16,000 employees of a Chinese company working remotely for nine months showed that, after this period, as many as half of them reported a desire to return to the office, despite the fact that the distance from home to the place of work was about 40 minutes each way. The desire to return to real-life interactions turned out to be stronger than the distance to be covered and the time invested in reaching the workplace.

The issue of social, mental and cultural consequences that will broadly affect people isolated from each other is also discussed by Professor N. Hertz (2022, pp. 196–219) of University College London. If we do not want the workplace to trigger loneliness, the challenge, among other things, is to appreciate kindness, collaboration and interaction. Although the prevalence of remote working has increased dramatically due to the pandemic, at the same time the focus on productivity is increasing, and employee supervision is also significantly intensified. Hertz (2022, pp. 198–208) also draws attention to the problem of loneliness that is inherent in remote working in its broad sense. In her opinion, loneliness at work results from loneliness felt outside of work. It concerns not only communication with the people among whom the work is carried out, but above all it is a feeling of being deprived of any agency and powerlessness.

Work that deprives people of their agency and entangles them in helplessness, powerlessness and deep loneliness may have many consequences that are difficult to remedy, especially in the long term. It should be expected that it will hinder or completely prevent self-reliance in action, decision-making, deprive employees of responsibility for the direction in which the work assigned to a particular person is heading, lower the quality of the intra-organisational relationships created. Thus, a human being becomes merely a cog in the machine, which is much easier to replace and which is much easier to dispose of if it stops working. While work performed in this way may be efficient in the short term, it can also affect the sense of purpose in doing it, the way employees see their role in the organisation and the relationships they create in their own professional space. They are often a source of inspiration, support, assistance and a very broadly understood interaction that ultimately determines what a human being creates in an organisation. This is also pointed out by Oliver (2021, p. 3) who claims that the impact of remote working on employees' mental health and productivity are key indicators of whether remote working is considered successful. These two indicators, however, are contradictory, which causes confusion as to how to strike a balance.

Nevertheless, remote working also has its positive side. The conclusions of the report prepared as a result of cooperation between Deloitte and Worldwide ERC (2021) show that one of the most important positive aspects of remote working is the ability to tap into a growing global talent pool, which allows businesses to remain

competitive. Employees located anywhere in the world provide an opportunity for the organisation to attract critical talent, a wide range of qualified individuals regardless of their location. Importantly, such expansion will require adapting organisational rules to local customs and cultures while on the other hand it must ensure consistency and fairness (Deloitte, Worldwide ERC, 2021). Similar conclusions are presented by Coffey and Wolf (2018, p. 4) who recognised the importance of accessibility to talent in the global labour market which is certainly one of the biggest benefits for organisations. Optimistic conclusions can also be drawn from *The Distributed Work Dilemma: When Innovation and Job Satisfaction Compete* research carried out by Vanson Bourne (2022) for VMware (global data were collected from 5,300 HR, IT, and business decision makers and employee-level respondents between July and August 2022). The research shows that 56% of EMEA respondents who work under a remote or hybrid model report increased morale, creativity (52%) and collaboration (53%) within their teams compared to prior to the COVID-19 pandemic. Importantly, the research also shows that the current economic climate means that it is employers who are gaining the upper hand over employees in the labour market (Vanson Bourne, 2022).

While it is widely acknowledged that remote working should be the employee's choice and not the employer's (Woźniak-Jęchorek, 2022, p. 43), some doubts have been raised, especially when it comes to the long-term consequences for the organisation of carrying out work in this way. It is difficult to accurately predict these consequences today, because the phenomenon of work carried out remotely on as large a scale as it is today has been present in the global professional environment for a relatively short period of time. Research conducted among 61,182 Microsoft employees in the United States in the first six months of 2020 shows that the current enthusiasm for remote working may not ultimately translate into a permanent shift to this form of working in most companies. The researchers point out that remote working has made the collaboration network of workers more static and siloed, with fewer bridges between disparate parts. Furthermore, there was a decrease in synchronous communication and an increase in asynchronous communication. This will make it harder for employees to acquire and share new information across the network (Yang *et al*., 2022, pp. 43–54). Negative consequences especially in the area of remote team management by managers of such projects are also highlighted by Parker, Knight and Keller (2020) – the researchers indicate that the problems relate to areas such as employee productivity (38% of the surveyed managers agreed that remote employees perform worse than those who work in an office), motivation to work in the long term, distrust in the competence of their own employees (29% of managers reported not trusting their employees' competence), and 27% assessed that employees lack essential skills. These results indicate that excessive optimism about the benefits provided by remote working today often does not take into account

the scale of the costs and threats it may face in the future, when it will be much harder to control the changes that have already taken place and much harder to return to the old model of working, which, although it does not always provide so much flexibility, nevertheless allows for greater control, better insight into problems and a quicker response from the organisation.

Today's world is becoming less and less comprehensible to many people. The COVID-19 pandemic, as the most significant event of recent years is just one element among many challenges that have arisen in the global space, but it has strongly affected our attitude to our own lives, the world, work, and consequently, other people. In the opinion of Taleb (2014, p. 31) it is "extreme events that should be taken as the starting point (...) for consideration, rather than treated as exceptions and swept under the carpet". In this context, important questions are posed by Obłój (2022, p. 196) who states that remote work, although similar to the work we knew before the pandemic but carried out remotely, after two years of the pandemic is not what we would like to see it. It is difficult to put into clear terms how it should be understood (and assessed) today. What is particularly important – he points out that it has dimensions that we know exist, but we do not know what their real consequences are. These are new legal situations for employees and organisations, a new way of coordinating and controlling employees. How to assess and promote people whom the employer has not seen for two years otherwise than through a computer? How to motivate and verify whether motivation is at the expected level? Although these aspects do not exhaust the issue, nevertheless they show how many questions arise from carrying out work remotely and how unclear and difficult it is to make sense of it today for the sake of the future.

These questions are particularly important in relation to the IT services sector, which is the youngest, but at the same time the most dynamically developing sector in Poland, in which remote working has become an established norm. The Polish IT market is one of the largest in Central and Eastern Europe, and its development is strongly affected by macro- and microeconomic factors (Wieszczycka, 2014, pp. 125–127). Both in Poland and in the European Union as a whole, there has been a serious problem for several years in recruiting IT professionals with the desired qualifications (Iskierka, Krzemiński & Weżgowiec, 2017, pp. 36–37) and an even greater one in retaining them on a long-term basis within a single organisation. Data prepared by the Polish Economic Institute for 2022 show that currently Poland falls short of 147,000 IT specialists to reach the same share of IT specialists in the total number of employees (in Poland) as that in the European Union. In Poland, IT specialists currently account for approx. 3.5% of all employees, one of the lowest figures in the EU. The data also show that Poland is short of 25,000 IT specialists – this is the difference between the actual number of specialists and that required by the economy. Poland currently employs approx. 586,000 IT specialists, with

an increase of approx. 192,000 over the last decade. The gap is significant, as it accounts for about 77% of the increase in the number of IT specialists over the last decade. The data from the report of the Polish Economic Institute leave no doubt – Polish companies have a problem in filling IT specialist positions. There is also a shortage of technical graduates to fill this gap. This deficit can only be filled to a certain extent by employees from Eastern Europe (Łukasik *et al*., 2022, pp. 5–7). In this situation, does it really make sense to permanently organise work in a form that dramatically changes the employee-organisation relationship?

## 3. Research Methodology. Characteristics of the Surveyed Sample, Methods and Tools Used in the Research

The research sampling was purposive. The criteria for inclusion in the surveyed sample, in the case of employees, were: occupation – a job in the IT services sector (programmers, testers, analysts, administrators, project managers, graphic designers) and remote working, while in the case of managers: the role of manager, head, director, coordinator, owner, IT project leader, HR manager at a company from the IT services sector or at a company with a different business profile, where there is a separate IT unit. Quantitative research covered a total of 100 employees in the IT services sector and 56 managers from the IT services sector representing micro, small, medium and large enterprises in Poland (Polish or foreign capital).

In both cases, the group is not representative, but the data obtained are intended to show the trends and some tendencies in the area under research. The research was carried out between 1 December 2022 and 1 February 2023.

99% of respondents declared working remotely. The largest group of respondents were programmers (36%), testers (17%), project managers (15%) and IT architects (13%). In the group of employees, 70 men and 30 women were examined. The majority (61%) were employees with higher technical education, 30% of the respondents had higher education, but with a profile other than technical. Most of the respondents came from large organisations employing more than 500 employees (23%) and from medium-sized organisations (31–50 employees) – 18%. The third highest result covered employees from organisations employing 16–30 employees (15%). 43 employees declared that they work for foreign clients – mainly from Denmark (18.6%), the United States (14%), Norway (11.6%) as well as Sweden and the UK – in both cases 9.3% of respondents declared work for customers from these countries. Most of the respondents live and work in the Mazowieckie voivodeship (61%), Łódź (11%) and Wielkopolskie (8%). In the study group, the average values for individual variables were: "Age", M = 38.87 (SD = 5.523), "Please specify the total work experience in years", M = 14.02 (SD = 4.992), "Please specify the size of the team where you currently work number of employees", M = 14.71 (SD = 13,491).

Almost all survey participants confirmed that they work remotely ($n$ = 99; 99%). Only one respondent denied this ($n$ = 1; 1%). In the study group, the average values for individual variables were as follows: "How long have you been working remotely? (years)", M = 3.40 (SD = 2,840), "How many times a week do you work remotely?", M = 4.69 (SD = 0.862).

In the group of managers, 33 women (58.9%) and 23 men (41.1%) were surveyed. Managers came from the following organisations: employing more than 250 employees (large enterprise) ($n$ = 23; 41.1%), 10–49 employees (small enterprise) ($n$ = 17; 30.4%), 50–250 (medium enterprise) ($n$ = 15; 26.8%), 1–9 employees (micro enterprise) ($n$ = 1; 1.8%). Managers participating in the study work in the following provinces in Poland: Mazowieckie ($n$ = 23; 41.1%), Małopolskie ($n$ = 8; 14.3%), Dolnośląskie ($n$ = 7; 12.5%), Lubuskie ($n$ = 3; 5.4%), Kujawsko-pomorskie ($n$ = 2; 3.6%), Lubelskie ($n$ = 2; 3.6%), Łódzkie ($n$ = 2; 3.6%), Pomorskie ($n$ = 2; 3.6%), outside Poland ($n$ = 2; 3.6%), Śląskie ($n$ = 2; 3.6%), Podkarpackie ($n$ = 1; 1.8%), Wielkopolskie ($n$ = 1; 1.8%), Zachodniopomorskie ($n$ = 1; 1.8%).

The research used proprietary surveys prepared for the purpose of research work, which were made available online for the respondents via the survio.com platform. The CAWI survey for a group of employees contained a total of 43 open and closed questions (single and multiple choice). The survey was delivered to the respondents via a direct link to the platform and was not time-limited in any way. Respondents were contacted by using the LinkedIn portal, which is, to some extent, a natural environment for the respondents, i.e., it is an online space used for strictly professional purposes and for direct searches in companies from the IT services sector. The survey was anonymous. The CAWI survey for a group of managers contained a total of 22 open and closed questions (single and multiple choice). The survey was not time-limited. The system accepted only complete surveys. Respondents were contacted by using the method of direct searches in companies from the IT services sector or in companies with a different business profile, where there is a separate IT unit.

## 4. Own Research Findings – the Group of Employees

The following statistical methods were used to carry out the analysis:

– a descriptive statistical analysis – basic measures of descriptive statistics to characterise the distribution of quantitative variables,

– a frequency analysis – percentage distributions of qualitative variables.

The analyses were carried out using Excel and Jamovi statistical packages.

In the opinion of employees, their task efficiency is high. Most of the survey participants strongly confirmed that they cared a lot about the quality and timeliness of tasks they performed remotely ($n$ = 65; 65%). 27% of the respondents reported that they did everything that was assigned to them ($n$ = 27). The remaining survey

participants selected the following answers: "definitely no, I often lack information, I have no one to exchange ideas and views with, I lack inspiration" ($n$ = 5; 5%), "rather yes" ($n$ = 2; 2%) and "rather no" ($n$ = 1; 1%).

Also, when it comes to assessing their own self-reliance, proactivity and responsibility for the tasks performed (when working remotely), the respondents most often rated themselves very highly ($n$ = 71; 71%). These features were rated as high by 28% of the survey participants, while only one person rated them as average ($n$ = 1; 1%). The research shows that long-term (over 12 months) remote work by employees is not conducive to shaping pro-development attitudes, hinders the building of team collaboration, and negatively affects the quality of relationships and trust within the team. The research shows that employees have been working in this model for almost 5 days a week for the last 3 years on average ($M$ = 4.69). In most cases, the respondents do not feel that they are gaining new knowledge and learning new things while working remotely ($n$ = 43; 43%). The remaining survey participants selected the following answers: "definitely no" ($n$ = 22; 22%), "rather yes" ($n$ = 20; 20%) and "definitely yes" ($n$ = 15; 15%).

The employees also tend to be negative when it comes to collaborating with a team with no day-to-day, face-to-face contact. The largest proportion of the respondents reported that they rather could count on the team with whom they had no direct contact ($n$ = 35; 35%) but a total of 49% of the respondents estimated that they rather could not, completely could not, or stated that they could only rely on themselves.

The employees working remotely also assess the level of relationships as rather average, describing them as correct, but certainly not deep. Nearly half of the participants assessed it as such ($n$ = 48; 48%). In contrast, the second highest rated answer was very good relations. Such a level was indicated by 23% of the respondents ($n$ = 23). The third highest rated answer was: relationships have broken down, we talk less, we are not interested in each other ($n$ = 17; 17%). Also, building trust within remote teams is one of the most frequently mentioned challenges within the group of employees.

Remote working limits opportunities for self-development, team learning, and knowledge exchange among employees. This is the highest rated challenge of all those indicated by the respondents. No possibility of learning directly from the team and/or the manager was indicated by almost half of the respondents ($n$ = 48; 48%). When asked whether they exchange knowledge with the team on which they work remotely, respondents also overwhelmingly declared that there is no knowledge exchange between team members. In most cases, the respondents are unlikely to share experiences and knowledge with the team they work with remotely ($n$ = 45; 55.6%). 29.6% of the respondents strive to do so ($n$ = 24). The other respondents

strongly denied this (everyone focuses on themselves and looks for information and inspiration on their own) ($n$ = 12; 14.8%).

The employees are negative about managers' activities when it comes to promoting the mutual exchange of knowledge, ideas, and information among employees, and encouraging them to undertake activities that will foster development. The largest group of the survey participants stated that in their work no one cared about the exchange of information, knowledge, and ideas ($n$ = 35; 35%). The answer "rather no" was given by 31% of the respondents ($n$ = 31). A significant number of the survey participants also chose the answer "rather yes" ($n$ = 22; 22%). The other respondents ticked the answers: "definitely yes" ($n$ = 8; 8%) and "everyone focuses on themselves" ($n$ = 7; 7%).

Despite the many negative aspects perceived by the surveyed employees, they declare that they are positive about the possibility of working remotely and expect to be able to continue working in this particular model (100% remote working). 82% of the respondents from the IT services sector declare that they want to work 100% remotely. Only 17% state that they prefer hybrid working.

Research shows that the predominant reasons for wanting to work remotely include: possibility of flexible working with a strong focus on personal preferences (75%), possibility of combining home and professional duties (64%), and the third highest rated answer was the possibility of attending private matters and obligations during the day (62%).

## 5. Own Research Findings – the Group of Managers

The following statistical methods were used to carry out the analysis:

– a descriptive statistical analysis – basic measures of descriptive statistics to characterise the distribution of quantitative variables,

– a frequency analysis – percentage distributions of qualitative variables,

– Fisher's exact test – to assess the relationship between two variables of a nominal nature for small size groups.

The significance level was set at $a = 0.05$ (if $p < 0.05$, the results are considered statistically significant). The analyses were carried out using Excel and Jamovi statistical packages.

The managers, unlike the employees, are negative about the level of task efficiency among their own employees working remotely. The survey findings show that employers are not so enthusiastic about the efficiency and quality of tasks that are performed by remote employees. The respondents most often indicated that the efficiency of tasks performed by employees working remotely was average ($n$ = 24; 42.9%). The remaining survey participants selected the following answers: "there are many errors, shortcomings, corrections, efficiency is low" ($n$ = 14; 25%),

"tasks are performed carefully and on time, efficiency is high" ($n$ = 13; 23.2%), and "tasks are not performed, often ignored, forgotten, efficiency is very low" ($n$ = 5; 8.9%). A total of 76.8% of the respondents state that the level of work efficiency is, on average, low or very low, which indicates a completely different perception of this area by the employees when compared to the managers.

In the context of the formulated research problems, it also seems reasonable to analyse what kinds of problem may result in low task efficiency, if any, are noticed by managers among employees working remotely. This was examined from the managers' point of view, with a gender split (female managers, male managers). The frequency analysis results show that the female managers are most likely to notice problems among employees such as looking for excuses not to attend online meetings or to be invisible, difficulty in controlling the task performance, difficulty in building team unity, while the male managers notice problems related primarily to building unity, finding excuses not to attend online meetings or to be invisible and difficulties in controlling the task performance. In the managers' opinion, work carried out by employees remotely requires a lot of self-reliance, responsibility and discipline. However, the managers are negative about the impact of long-term remote working on employees. The analyses on the group of managers show that over 98% of their employees have been working remotely for over 12 months, which may be considered a long period.

The managers are negative about the impact of remote working on the level of collaboration and understanding within teams. Most often, the participants rated the impact of remote working on the level of collaboration and understanding within the team among its members as average ($n$ = 22; 39.3%). 33.9% of the survey participants indicated a low level of collaboration and understanding ($n$ = 19). The other answers were selected less frequently: "level of collaboration and understanding is high" ($n$ = 11; 19.6%), "level of collaboration and understanding is very low" ($n$ = 3; 5.4%), and "level of collaboration and understanding is very high" ($n$ = 1; 1.8%).

The managers also notice psychological, social and organisational problems. The most frequently noticed problem was the alienation of employees, e.g. missing meetings, not reporting absence from meetings ($n$ = 28; 50%), while the second most visible problem were psychological problems (depression, low mood, $n$ = 25; 44.6%). The managers also pointed out that employees were afraid to ask about various issues out of fear that it would harm their image within the team and the manager.

The survey participants (the group of managers), when working with remote employees, most often missed "responsibility for the assigned tasks" ($n$ = 43; 78.2%). It was indicated slightly less often that, when working remotely, the following were lacking: "greater self-reliance of the employee in task performance" ($n$ = 32; 58.2%), "trust in the employee" ($n$ = 32; 58.2%) and "good communication and mutual

understanding" ($n$ = 27; 49.1%). Other shortcomings were indicated by 3.6% of the respondents ($n$ = 2).

Among the features and skills that an employee should have to effectively carry out remote work and ensure efficient performance of professional tasks, the survey participants most often included: "high self-reliance" ($n$ = 39; 69.6%) and "a high level of responsibility for the tasks performed" ($n$ = 37; 66.1%). The following features were mentioned less often: "very good communication skills" ($n$ = 21; 37.5%), "very good organisation of own work" ($n$ = 15; 26.8%), "strong commitment to tasks" ($n$ = 12; 21.4%), "diligence" ($n$ = 8; 14.3%), "proactivity" ($n$ = 8; 14.3%) and "courage to express one's own thoughts and opinions" ($n$ = 6; 10.7%). The least often indicated were the following: "high focus on the quality of the tasks performed" ($n$ = 5; 8.9%), "good knowledge of the objectives of the organisation" ($n$ = 4; 7.1%), "team discussion skills" ($n$ = 3; 5.4%), "active listening skills" ($n$ = 3; 5.4%) and "ability to conform" ($n$ = 2; 3.6%).

In the long term, the managers see more threats and difficulties when it comes to organising remote working. The largest proportion of the respondents, in the long term, "see more threats and difficulties related to organising remote working" ($n$ = 26; 46.4%). "A lot of threats and problems related to organising remote working" are mentioned by 28.6% of the survey participants ($n$ = 16). Other answers were indicated less often.

Most of the managers have limited trust in a team working remotely ($n$ = 35; 62.5%). Distrust was indicated by 16.1% of the respondents ($n$ = 9). Only 14.3% of the survey participants trust their team ($n$ = 8), while in the remaining cases the trust is very strong ($n$ = 4; 7.1%).

As regards the group of managers, we also examined whether there were differences between female and male managers in the assessment of the level of collaboration and understanding within the team and trust in employees working remotely, their effectiveness, efficiency, and focus on professional tasks during working hours. The analysis of the relationship between nominal variables was preceded by checking the assumption of the application of the $\chi^2$ association test for a sufficiently large number of expected values (all expected values > 1; 80% of expected values > 5). This condition was not met by any of the pairs of variables, therefore Fisher's exact test was used for the analysis. The results of Fisher's exact test show that there is a significant relationship between the variable: "gender" and the variable: "To what extent do you trust your employees when it comes to working remotely? (work efficiency, organisation and effectiveness of own work, focus on professional tasks during working hours, etc.)", $p$ = 0.028; the strength of the observed effect was found to be moderate (Cramer's V = 0.39, 95% CI [0; 0.61]). The results of Fisher's exact test are presented in Table 1.

Table 1. Fisher's Exact Test Results – Relationship between the "Gender" Variable and Collaboration, Understanding, Trust, Efficiency and Effectiveness at Work

| Specification | *n* | *p* | Cramer's V | 95% CI | |
|---|---|---|---|---|---|
| | | | | lower | upper |
| How do you think remote working affects the level of collaboration and understanding within the team among its members? | 56 | 0.327 | 0.30 | 0.00 | 0.49 |
| To what extent do you trust your employees when it comes to working remotely? (work efficiency, organisation and effectiveness of own work, focus on professional tasks during working hours, etc.) | 56 | 0.028* | 0.39 | 0.00 | 0.61 |

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: the author.

## 6. Discussion of the Findings

The findings presented in this paper show selected issues that are a part of a larger field of research on employees and managers in the IT services sector. The findings obtained indicate some tendencies within the group in question. This is a contribution to further research and exploration, especially as remote working is a working model that is very strongly represented in the IT sector. The research also shows that employees expect this model to be maintained in the future. Despite the ongoing economic crisis in Poland, the IT sector is one of the most rapidly growing sectors in the country. Employment in this sector remains at a high level all the time, which only confirms that the demand for specialists does not fall – all the more so since, as the findings of this research also show, a large proportion of IT employees also work for foreign companies (Scandinavian countries, UK, USA are popular choices). However, the findings presented herein show the negative side of the working model so willingly chosen by employees. Particular attention should be paid to the issue of knowledge exchange. This is an area that requires special consideration when it comes to hiring specialists and planning project work. The research shows that exchange of knowledge among employees working remotely is at a low level. This problem is particularly acute when it comes to the formation of new teams in a market that is already experiencing a severe shortage of employment. With such work organisation, there may be a problem of knowledge exchange between senior and junior specialists. In other words, young employees may not have a source from which they can draw knowledge and thus supply the market with capital of new knowledge and skills. Senior specialists already generate very high costs in terms of remuneration levels in organisations,

and these expectations will grow if the labour market is not replenished with fresh groups of specialists, and seniors are given ample opportunities to choose a job, even outside Poland, which, according to the research, is currently the case. There is a gap between those who have knowledge, skills, and experience and those who are just starting their career in IT and do not have the opportunity to learn and benefit from the experience of seniors. The research shows that quite a large group of employees carry out projects remotely for foreign clients and, moreover, some employees carry out several projects simultaneously (e.g., for multiple employers at the same time). As remote working in IT is not a problem today, senior specialists may choose offers from outside Poland that are much more favourable in financial terms, which will further increase the outflow of human capital in the IT sector, which is already in deficit. In this case, similarly – young specialists will lose a source of learning. Intensification of these processes is certainly not conducive to ameliorating the problem of employment in IT in Poland, which prompts us to consider whether the remote model preferred by IT employees will not, in the long term, become a major threat to organisations in Poland which today decide to retain it for fear of an outflow of human capital. How far can organisations afford to make concessions today so as not to suffer the severe consequences of these decisions in the future? The high flexibility of organisations in this area combined with the lack of control and distrust in the employee raises serious concerns about the shape of cooperation between the employee and the organisation in the future, especially in such a difficult market.

Many alarming questions are also raised by the issue of why employees want to work remotely. One cannot expect high quality, timeliness and effectiveness (which, in the managers' opinion, are missing) if the main reason for wanting to work in this way is the possibility of attending to private matters and obligations during working hours. This leaves much room for abuse that will be difficult to control and eliminate. Large discrepancies between employees and managers in key areas such as trust, knowledge exchange and communication also give rise to concerns about the quality of mutual relationships in the future. Today, these two groups already perceive the same aspects of work in completely different ways. Remote working is likely to deepen the problems that plague organisations today, because it makes it impossible to notice problems more quickly and, consequently, respond to them. And finally, there are social, psychological and relational problems that have been plaguing employees in many regions of the world since the start of the COVID-19 pandemic. The question remains open as to whether the excessive enthusiasm over the present benefits of remote working will turn against organisations in the future, and how we, as employees, want to shape the work that is a significant part of our lives?

It is also worth paying attention to the limitations that emerged during the research and may be important when formulating conclusions. First of all, the surveyed group of employees is relatively small, which does not mean, of course, that research in this area should not be undertaken, but a larger sample could provide a broader picture of the examined issues. The surveyed group of managers was similarly small. It would also be worth conducting in-depth individual interviews with managers, which would give them the opportunity to learn about a wider range of concerns, problems, difficulties or, conversely the benefits they see from working in a remote model. Further research on this issue should focus on the relationship between employees' perception of remote work and variables such as age, gender, value system, or lifestyle. When thinking about further research on this issue, it is also worth paying attention to the cultural aspect, as well as the relationship between the perception of remote work and new trends in organisational behaviours.

### Conflict of Interest

The author declares no conflict of interest.

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# A Comparative Analysis of the Diffusion of Mobile Technologies in the Visegrad Four Using an ECM Model

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## ABSTRACT

**Objective:** The aim of the paper is to assess the size and rate of diffusion of mobile technologies in the processing industry, and to determine the nature and strength of the impact of investment specialisation (investment attractiveness) and industry export specialisation on this phenomenon in the four Visegrad Group countries.

**Research Design & Methods:** The occurrence of innovation diffusion and its dynamics were examined using an econometric model of the Gompertz function. To study the impact of specialisation according to foreign direct investments (FDI) located in V4 countries and their export specialisation on the process of innovation diffusion, an error correction model (ECM) estimated for selected industrial processing sectors was used. It was based on data for 2010–2021 from Eurostat, UNCTAD and the national statistical offices of individual V4 countries.

**Findings:** The phase of rapid increase in innovation diffusion calculated on the basis of the Gompertz function was significantly longer in high- and medium-high technology enterprises than in low- and medium-low technology enterprises. In the short term, the determinants of mobile technology diffusion in all V4 countries in industries with low and medium-low technology are both export specialisation and investment attractiveness.

**Implications/Recommendations:** The results lead to the conclusion that the diffusion of mobile technologies takes place in various industries in the V4, but its pace varies depending on the individual industry's technological development. The results indicate the need to develop industries with high technologies and sectors with high intensity of knowledge.
**Contribution:** A comparative analysis of the pace of diffusion of mobile technology innovations in the V4 was performed for the first time in this article. The combination of the Gompertz model with the ECM model can also be considered a pioneering solution in the analysis of innovation diffusion.

**Article type:** original article.

**Keywords:** diffusion of innovation, V4 countries, ECM, Gompertz function.

**JEL Classification:** O30, C22.

## 1. Introduction

Innovations combined with the knowledge-based economy play a pivotal role in shaping the competitive advantage of the modern economy, both on the macro- and microeconomic scales. Digital innovations developed in parallel with mobile technologies play a particularly important role. Recently, these technologies have become a common solution, an inseparable element of the lives of both individual users and the functioning of entire enterprises. The development of mobile technologies has been achieved thanks to numerous inventions and improvements regarding the portable nature of new devices, their intuitive and simple operation and the possibility of connecting them to the Internet. The low cost of buying and using this type of equipment also plays a meaningful role.

Mobile technologies are a key element of the digital economy and play an important role in increasing innovation and the competitiveness of organisations. Thanks to such technologies, the time needed to access information is shortened, while the communication process itself is improved. Mobile technologies enable the implementation of many digital innovations for social and business purposes. A large number of companies already widely use or even base their existence on available mobile technologies. They not only change the way traditional services such as transport and logistics function, but they are an invaluable improvement in processes such as the organisation of production, the provision of services, and the development of customer relationships. As a result, completely new business models are created, for example within the "sharing economy". Creating new mobile technology is generally expensive, and requires a large scientific and research base.

New mobile technology generally reaches the countries of Central and Eastern Europe through innovation diffusion. This term can be understood as the dissemination of innovation/technology through market and non-market channels, starting

from their initial implementation anywhere in the world, and later spreading to other countries and regions and to other markets and companies (OECD/Eurostat, 2005). Such diffusion spreads new technological, organisational, and marketing solutions, as well as knowledge among enterprises-imitators and copycats (the spillover effect). An important feature of technological innovation diffusion is its variable rate of spread, which usually changes according to the S-shaped curve (e.g. logistic curve), which means that the rate of diffusion in its initial phase is slow, then increases more than proportionally and decreases again in the final phase.

The logistics curve is the most commonly used tool to study the diffusion of technological innovations. Other tools include the Bass model (Bass, 1969) and the wave and hierarchical model (Morrill & Manninen, 1975) among others. Technology diffusion occurs in both developed and developing economies and has been the subject of numerous empirical analyses. While the global literature offers no shortage of research on the diffusion of mobile technology using the above models, studies using econometric tools in Poland and in other Visegrad Group countries (Czech Republic, Hungary, Slovakia) are relatively rare. The existing research gap in this area makes it difficult to reliably assess the actual relationships between spillover processes and certain macroeconomic variables. This article attempts to fill this gap to some extent. The main objective of the present analysis is twofold: to assess the size and rate of diffusion of mobile technologies in the processing industry, and to determine the nature and strength of the impact of investment specialisation (investment attractiveness) and industry export specialisation on the diffusion of tech innovations in the four Visegrad Group countries (the Visegrad Four, V4). The occurrence of mobile technology diffusion and its rate was studied using the Gompertz function. Additionally, to determine the impact of the investment attractiveness of individual V4 countries and their specialisation in foreign trade on diffusion processes, dynamic error correction models (ECM) were used. These were estimated for industrial processing industries with various degrees of technological advancement. This research approach made it possible to determine how the technological progress of the industry affects the rate of innovation diffusion, and how the intensity of diffusion is affected by the revealed innovation advantage and investment attractiveness of the individual V4 countries.

## 2. Literature Review

Innovation diffusion has been studied at length and for years. The classic approaches to this problem can be found in the works of Tarde (1895), Rogers (1962), and others. Researcher interest in the phenomenon is attributable to its key role in supporting the technical progress of many economies.

One research stream in the study of innovation diffusion involves analyses of the profitability of business ventures, pricing policy, distribution channels or,

in a broader sense, the strategy policy of the company introducing products to other markets. Studies of this type look at the diffusion of digital innovation in general (e.g. Akçura & Altınkemer, 2010). As mobile technologies have developed, and devices such as smartphones and tablets emerged, researchers have also analysed the diffusion of innovation in this area. Another important research stream focuses on the analysis of innovation life cycles (Peres, Muller & Mahajan, 2010). As part of this research, mathematical models of innovation growth curves have been built to calculate and analyse a range of factors including inflection points and saturation levels. These studies aim to reflect the diffusion processes over time as accurately as possible, so that it is possible to create sales forecasts and develop effective commercial strategies (Mahajan, Muller & Bass, 1990).

Researchers have proposed many models that work well in specific socio-economic conditions (Meade & Islam, 1995). Much of the research on diffusion concerns innovations related to high-tech products such as mobile telephones, mobile technologies, digital technologies, and the Internet. One of the groundbreaking models in the study of this type of issue is the Bass model (Bass, 1969). There is research indicating that this model is not appropriate for the diffusion mapping of some more technologically advanced products. However, basic growth curve models, such as the Gompertz model, the logistic model, or a modified exponential model, accurately reflect these phenomena (Singh, 2008; Liu, Wu & Chu, 2009). The diffusion of mobile and digital innovations has been modelled widely in recent years. For example, in banking, Dos Santos and Peppers (1998) modelled the effectiveness of different diffusion models in analysing the spread of e-commerce applications. Singh (2008) studied the diffusion of mobile telephony in the Indian market using logistic curve models and the Gompertz function. The author showed that the latter function better reflects the diffusion in question. More recently, Roy, Dutta and Das (2019), Asongu (2021), and Skiti (2020) have studied the determinants of mobile technology diffusion processes.

In the Polish literature, studies of innovation diffusion have been done by Klincewicz (2011), Firlej and Żmija (2014), Wiśniewska (2004), and Gwarda-Gruszczyńska (2017). Empirical studies of the process of diffusion of innovation in the world literature have been conducted for years using econometric modelling (Bemmaor & Lee, 2002; Teng, Grover & Guttler, 2002; Desiraju, Nair & Chintagunta, 2004; Van den Bulte & Stremersch, 2004) or by means of simulation studies (Ramkumar *et al*., 2022), but the Polish literature offers few examples of the use of such tools (Kolarz, 2006, is one). There is a similar paucity in other Central and Eastern European countries (including the other V4 nations). Meanwhile, econometric modelling is already a well-established tool globally in the study of innovation diffusion. Models of this type allow for a real assessment of cause-and-effect relationships

between spillover processes and macroeconomic variables, while also enabling forecasting of the diffusion process itself.

Thus, a research niche exists in this area, opening the field for in-depth analyses in the area of innovation diffusion, especially of innovations in dynamically developing mobile technologies, both in Poland and in other countries of Central and Eastern Europe. The research subject of this study is the proliferation of portable electronic devices enabling mobile access to the Internet, with which employers in enterprises of the processing industry equip their employees in the countries of the V4.

## 3. Research Methodology

Innovation diffusion typically commences slowly before rapidly picking up speed. It then decreases and the level of innovation stabilises (the growth dynamics of innovation diffusion fades). Many studies have confirmed that changes in the innovation diffusion rate follow an S-shaped curve (Sharif & Kabir, 1976; Desiraju, Nair & Chintagunta, 2004). For this reason, in research on the dynamics of innovation diffusion, models are used that allow researchers to reproduce the behaviour of this phenomenon. These include, above all, the logistics model and the Gompertz model. This article applies the Gompertz model, which works well in similar analyses (Meade & Islam, 1995; Liu *et al*., 2014). The Gompertz curve shows the exponential rate of change of the phenomenon, which follows an asymmetric sigmoid path around the inflection point. This type of asymmetry is suitable primarily for describing cases in which maximum growth occurs relatively early (Meade & Islam, 1995, 2006). The Gompertz function is represented by the formula:

$$f(t) = A\exp(-\exp(-B(t-C))), \tag{1}$$

where:

$A, B, C$ – parameters of the Gompertz function, where: $A$ – the supremum of the values of the function, $C$ – scale parameter,

$t$ – time variable.

The rate of change in the Gompertz function is provided by the formula:

$$GRG = \frac{dy}{dt}\frac{1}{y} = B\exp(-B(t-C)). \tag{2}$$

In the course of the Gompertz function, several ranges can be distinguished, including the area where it has a clearly increasing growth rate and the area where it is characterised by a decreasing growth rate, aiming at the saturation level expressed by the asymptote $y = A$. The point separating the rapid growth rate of the curve from the decreasing growth rate is the inflection point with coordinates:

$$\frac{dy}{dt}\frac{1}{y}(C) = B. \tag{3}$$

Liu, Wu and Chu (2009) proved that the condition for an inflection point to appear is that approximately 37% of consumers accept the innovation.

The competitiveness of foreign trade was measured using the *RCA* (revealed comparative advantage) indicator (Balassa, 1965):

$$RCA_i = \frac{Ex_{ij}}{Ex_j} : \frac{Ex_i^R}{Ex^R}, \tag{4}$$

where:

$Ex_{ij}$ – export value of the *i*-th industry in the *j*-th country,
$Ex_j$ – total value of exports of the *j*-th country,
$Ex_i^R$ – the value of exports of the *i*-th industry in the reference countries,
$Ex^R$ – the total value of exports in the reference countries.

Indicator (4) enables us to assess the relative comparative advantage of one country in exporting a specific commodity group over other countries. The higher the value it takes, the greater the advantage in exports the country under analysis has. Values greater than one are considered to indicate the existence of a comparative advantage, and values less than one indicate the absence of one. In the calculations of the *RCA* index, OECD countries were adopted as a reference group, due to the trade and investment relations of the V4 countries with these countries and their technological advancement, which makes it possible to seamlessly transmit innovation to the Visegrad countries.

As was done with indicator (2), the indicator of disclosed investment advantage is defined. This measure makes it possible to takie into account the country's investment attractiveness. This indicator is given by the formula (Salamaga, 2020):

$$RCAI_i = \frac{FDI_{ij}}{FDI_j} : \frac{FDI_i^R}{FDI^R}, \tag{5}$$

where:

$FDI_{ij}$ – the value of the FDI stocks in the *i*-th industry in *j*-th country,
$FDI_j$ – the total value of the FDI stocks in the *j*-th country,
$FDI_i^R$ – the value of FDI stocks in the *i*-th sector in reference countries,
$FDI^R$ – the total FDI stocks in reference countries.

The higher the investment attractiveness of a country, the higher the *RCAI*. Because foreign direct investment (FDI) suppliers to the Visegrad countries are also non-OECD countries, all countries in the world were assumed as reference countries when calculating the *RCAI*. The relationships between variables (3), (4) and (5) were analysed using a one-equation model with the error correction mechanism. The short-term relationship in the ECM model between logarithmic variables is described by the equation:

$$d\_lnGRG_t = \alpha_0 + \alpha_1 d\_lnRCA_t + \alpha_2 d\_lnRCAI_t + \alpha_3 ECM_{t-1} + \varepsilon_t, \tag{6}$$

where:

$\alpha_0$, $\alpha_1$, $\alpha_2$, $\alpha_3$ – model parameters,

$d\_lnGRG_t$, $d\_lnRCA_t$, $d\_lnRCAI_t$ – first differences of logarithmic variables: *GRG* (growth rate of the Gompertz function), *RCA* (revealed comparative advantage), *RCAI* (investment attractiveness of a country),

$ECM_{t-1}$ – error correction mechanism,

$\varepsilon_t$ – error term.

The ECM component represents the state of long-term equilibrium in the previous period ($t - 1$) in relation to period $t$. The cointegrating equation representing the long-term relationship is:

$$lnGRG_t = \gamma_0 + \gamma_1 lnRCA_t + \gamma_2 lnRCAI_t + u_t. \tag{7}$$

In the case of autocorrelation occurring in the model (6), lagged variables were also introduced. Before estimating the model, the internal structure of time series was studied, and their order of cointegration and autocorrelation was tested. In the study of time series stationarity, the augmented Dickey-Fuller test (ADF test) was used, while the Engle-Granger test was used in the time series cointegration study.

The study of mobile technology diffusion was based on statistics regarding the number of mobile devices enabling mobile access to the Internet, such as laptops and smartphones companies distribute to employees. Models of Gompertz curves (1) of mobile technology diffusion were built and the growth rate of these functions (*GRG*) were calculated according to formula (2) for each year on the basis of data for 2010–2021 from Eurostat and the national statistical offices of individual V4 countries (Statistics Poland, the Czech Statistical Office, the Statistical Office of the Slovak Republic, and the Hungarian Central Statistical Office). Data on FDI holdings in the Visegrad countries (used to calculate the *RCAI*) were also taken from Eurostat and from the databases of national statistical offices. Export data used to calculate the *RCA* were taken from the Comext database available in Eurostat, which contains detailed statistics on the international trade of individual EU Member States. For calculations, data at a double-digit level of commodity disaggregation based on the Standard International Trade Classification (SITC) were used, as were data from the UNCTAD database. When selecting the parameters of the Gompertz function, the Gauss-Newton optimisation algorithm was applied. Gompertz function and ECM models were built on annual data, because only this frequency of data was available.

## 4. Empirical Results

The modelling of mobile technology diffusion was carried out using the Gompertz function among enterprises belonging to industries that utilise different

levels of technology. Two business sectors were taken into account: those operating in low- and medium-low technology sectors and in sectors with high and medium technologies (Table 1).

Table 1. Results of the Estimation of Gompertz Regression Function Parameters among Enterprises Uutilising Different Levels of Technology

| Specification | Sector | | | | | |
|---|---|---|---|---|---|---|
| | Low-tech and medium-low-tech | | | High-tech and medium-high-tech | | |
| Czech Republic | | | | | | |
| Parameter | A | B | C | A | B | C |
| Coefficient | 2,291.965 | 0.579 | 2.900 | 5,679.211 | 0.521 | 4.188 |
| Standard error | 862.441 | 0.169 | 1.060 | 1,922.235 | 0.187 | 1.131 |
| *p*-value | 0.033 | 0.011 | 0.029 | 0.021 | 0.027 | 0.008 |
| $R^2$ | 0.753 | | | 0.779 | | |
| Hungary | | | | | | |
| Parameter | A | B | C | A | B | C |
| Coefficient | 1,731.996 | 0.621 | 2.707 | 4,744.469 | 0.523 | 3.434 |
| Standard error | 330.395 | 0.081 | 0.431 | 2,714.591 | 0.282 | 2.427 |
| *p*-value | 0.001 | 0.000 | 0.000 | 0.124 | 0.106 | 0.200 |
| $R^2$ | 0.743 | | | 0.752 | | |
| Poland | | | | | | |
| Parameter | A | B | C | A | B | C |
| Coefficient | 6,016.894 | 0.548 | 2.779 | 7,649.087 | 0.584 | 3.751 |
| Standard error | 1,451.276 | 0.150 | 0.766 | 1,666.511 | 0.192 | 1.942 |
| *p*-value | 0.004 | 0.008 | 0.008 | 0.003 | 0.019 | 0.095 |
| $R^2$ | 0.591 | | | 0.626 | | |
| Slovakia | | | | | | |
| Parameter | A | B | C | A | B | C |
| Coefficient | 859.532 | 0.503 | 3.761 | 948.502 | 0.511 | 4.485 |
| Standard error | 245.330 | 0.058 | 0.412 | 883.507 | 0.192 | 1.954 |
| *p*-value | 0.010 | 0.000 | 0.000 | 0.319 | 0.033 | 0.055 |
| $R^2$ | 0.702 | | | 0.784 | | |

Source: the author's calculations.

Table 1 shows that the phase of rapid increase in innovation diffusion calculated on the basis of the Gompertz function was significantly longer in high- and medium-high technology enterprises than in low- and medium-low technology ones. The models built for low- and medium-low technology had statistically significant

parameters, while some parameters in the models for high- and medium-high technology were not statistically significant (especially for Hungary). Among companies from the high- and medium-high technology sectors, companies operating in Slovakia had the longest phase of rapid mobile technology diffusion dynamics (about 54 months), and the shortest was experienced by Hungarian companies (about 41 months). Similarly, in low- and medium-low technology industries, Slovakian companies recorded the longest phase of rapid diffusion of mobile technology (about 45 months), and the shortest duration was among Hungarian companies (about 33 months). Companies from Poland operating in high- and medium-high technology industries achieved the highest growth rate of innovation diffusion (0.58), calculated at the inflection points of the Gompertz function, while companies from Slovakia (0.51) achieved the lowest. Slovak companies also had the lowest growth rate of innovation diffusion in low- and medium-low technology industries (approx. 0.50), while the highest growth dynamics were recorded in these industries by enterprises in Hungary (approx. 0.62).

*GRG* values calculated for individual years of the period considered, together with *RCA* and *RCAI* indicators, were used to estimate dynamic econometric models. The variables were first logarithmised, and the construction of econometric models was preceded by a study of the stationarity of time series of variables using the ADF test. As a result, the use of this test was confirmed by the integration of time series in stage I(1) at a significance level of 0.05. The ADF test, applied to residuals calculated from the corresponding integrating equations (7), showed that their time series are integrated in order I(0). Due to the cointegration of the time series of variables *lnGRG*, *lnRCA*, *lnRCAI* in order I(1), dynamic econometric models for short-term relations containing an error correction mechanism were estimated.

Tables 2 and 3 present the results of estimates of the parameters of mobile diffusion rate models, which show the long- and short-term relationship for enterprises in low- and medium-low technology and high- and medium-high technology.

Based on the parameter assessments in Table 2, it can be concluded that in the short-term export specialisation and investment attractiveness are the determinants of mobile technology diffusion in all V4 countries in industries with low and medium--low technology. The first of these indicators had a particularly clear impact on the intensity of mobile technology diffusion in the industries under discussion in the Czech Republic, where an increase in the *RCA* index by 1% implies an increase in the rate of diffusion of innovation by an average of about 0.789 *ceteris paribus*. On the other hand, the strongest impact of investment attractiveness on the rate of mobile technology diffusion in low- and medium-low technology industries is visible in Hungary, where a one percent increase in the RCA index implies an increase in the rate of diffusion of innovation by an average of about 1.058% *ceteris paribus*. According to the results presented in Table 2, in industries with

Table 2. ECM Parameters in V4 Countries by Industries Utilising Different Levels of Technology

| Variable | Sector | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Low-tech and medium-low-tech | | | | High-tech and medium-high-tech | | | |
| | Parameter | SE | *t*-Stat | *p* | Parameter | SE | *t*-Stat | *p* |
| Czech Republic | | | | | | | | |
| *const* | –5.016 | 2.035 | –2.465 | 0.069 | –1.568 | 0.551 | –2.849 | 0.046 |
| *d_lnGRG_1* | 1.285 | 0.175 | 7.362 | 0.002 | 1.076 | 0.492 | 2.187 | 0.094 |
| *d_lnRCA* | 0.789 | 0.183 | 4.317 | 0.012 | 0.279 | 0.336 | 0.829 | 0.454 |
| *d_lnRCAI* | 0.536 | 0.154 | 3.472 | 0.026 | 2.828 | 0.904 | 3.130 | 0.035 |
| *ECM_1* | –0.267 | 0.181 | –1.479 | 0.213 | –0.037 | 0.008 | –4.643 | 0.010 |
| $R^2$ | 0.688 | | | | 0.583 | | | |
| Hungary | | | | | | | | |
| *const* | –3.749 | 1.558 | –2.406 | 0.074 | –0.246 | 0.397 | –0.619 | 0.569 |
| *d_lnGRG_1* | 1.355 | 0.212 | 6.384 | 0.003 | 1.356 | 0.546 | 2.484 | 0.068 |
| *d_lnRCA* | 0.475 | 0.118 | 4.030 | 0.016 | –1.209 | 0.785 | –1.541 | 0.198 |
| *d_lnRCAI* | 1.058 | 0.185 | 5.711 | 0.005 | 2.405 | 0.806 | 2.986 | 0.041 |
| *ECM_1* | –0.088 | 0.211 | –0.418 | 0.698 | –0.040 | 0.012 | –3.243 | 0.032 |
| $R^2$ | 0.819 | | | | 0.697 | | | |
| Poland | | | | | | | | |
| *const* | –0.063 | 0.017 | –3.765 | 0.020 | –0.183 | 0.054 | –3.427 | 0.027 |
| *d_lnGRG_1* | 1.294 | 0.282 | 4.589 | 0.010 | 0.499 | 1.115 | 0.448 | 0.677 |
| *d_lnRCA* | 0.069 | 0.024 | 2.928 | 0.043 | –1.213 | 0.406 | –2.987 | 0.040 |
| *d_lnRCAI* | 0.128 | 0.033 | 3.889 | 0.018 | 1.241 | 0.634 | 1.956 | 0.122 |
| *ECM_1* | –0.095 | 0.021 | –4.494 | 0.011 | –0.093 | 0.024 | –3.852 | 0.018 |
| $R^2$ | 0.620 | | | | 0.583 | | | |
| Slovakia | | | | | | | | |
| *const* | –2.486 | 1.029 | –2.416 | 0.073 | –0.206 | 0.033 | –6.157 | 0.004 |
| *d_lnGRG_1* | 1.321 | 0.238 | 5.555 | 0.005 | 0.771 | 0.251 | 3.080 | 0.037 |
| *d_lnRCA* | 0.945 | 0.309 | 3.058 | 0.038 | –0.086 | 0.021 | –4.054 | 0.015 |
| *d_lnRCAI* | 0.886 | 0.299 | 2.965 | 0.041 | 3.096 | 0.325 | 9.512 | 0.001 |
| *ECM_1* | –0.141 | 0.106 | –1.324 | 0.256 | –0.061 | 0.021 | –2.843 | 0.047 |
| $R^2$ | 0.714 | | | | 0.765 | | | |

Source: the author's calculations.

high and medium-high technology, the statistically significant impact of both export competitiveness and investment attractiveness on mobile technology diffusion is visible only in Slovakia, with the first of these factors being a destimulant and the second being a stimulant: an increase in the *RCA* index by 1% causes a decrease in

the rate of diffusion of innovation by an average of approx. 0.086% *ceteris paribus*, and the same increase in *RCAI* implies an increase in *RCA* by approx. 3.096% *ceteris paribus*. In addition, in these industries, competitiveness in foreign trade is also an important destimulant to the intensity of innovation diffusion among Polish enterprises, while investment attractiveness significantly accelerates the pace of diffusion of mobile technologies in the Czech Republic and Hungary. The calculations show that, in the short term, in low- and medium-low technology industries, both foreign trade and foreign direct investment are important transmission channels for innovation diffusion, while in the case of high-tech and medium-high technology industries, foreign direct investments are such a channel. Assessments of the parameters of the error correction mechanism are generally negative, which indicates an adjustment of short-term changes to the long-term equilibrium in the Visegrad Group countries. Table 3 presents the parameters of cointegration equations for enterprises belonging to industries that utilise different levels of technology. The coefficients of determination show that the fit of the models to the data is usually average, and in some cases the $R^2$ is even less than 50% (for high- and medium-high technology in Czech Republic and Slovakia).

In terms of the long-term relationship in low- and medium-low technology industries (see Table 3), the positive impact of *RCA* and *RCAI* indicators on the rate of change of innovation diffusion as measured by the *GRG* indicator is also confirmed. However, here the impact of the investment attractiveness index is generally stronger (with the exception of Poland) than that of the export competitiveness index. The strongest long-term impact of export advantage in these industries on the rate of innovation diffusion occurs in Slovakia, where a one percent increase in the *RCA* indicator causes an increase in the rate of mobile technology diffusion by an average of approx. 2.914% *ceteris paribus*. On the other hand, the most pronounced impact of investment attractiveness on the speed of innovation diffusion is visible in the Czech Republic – where an increase in the *RCAI* by 1% results in an increase in the *GRG* index by an average of approx. 3.726% *ceteris paribus*.

Thus, it can be argued that foreign investment is a more effective transmission channel for innovation diffusion than foreign trade. The situation is slightly different in industries with high and medium-high technologies where, although investment attractiveness is generally a factor that significantly supports the diffusion of mobile technology, competitiveness in exports more often limits this diffusion or does not significantly affect it. According to the results in Table 3, the strongest impact of innovation advantage in these industries on the rate of diffusion of innovation can be observed in Poland, where a one percent increase in the *RCAI* causes an increase in the *GRG* index by an average of approx. 4.381%. At the same time, the most inhibiting impact of the dominance in foreign trade on the diffusion rate is visible in Hungary, where an increase in the *RCA* index by 1% results in a decrease in the

Table 3. Parameters of Cointegration Equations for Enterprises Belonging to Industries That Utilise Different Levels of Technology

| Variable | Sector | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Low-tech and medium-low-tech | | | | High-tech and medium-high-tech | | | |
| | Parameter | SE | *t*-Stat | *p* | Parameter | SE | *t*-Stat | *p* |
| Czech Republic | | | | | | | | |
| *const* | –7.499 | 0.922 | –8.136 | 0.000 | –1.509 | 1.258 | –1.199 | 0.265 |
| *lnRCA* | 2.760 | 3.256 | 0.848 | 0.421 | –0.278 | 0.115 | –2.411 | 0.042 |
| *lnRCAI* | 3.726 | 0.742 | 5.021 | 0.001 | 3.087 | 0.853 | 3.620 | 0.007 |
| $R^2$ | 0.935 | | | | 0.416 | | | |
| Hungary | | | | | | | | |
| *const* | –6.581 | 1.057 | –6.228 | 0.000 | –3.427 | 1.784 | –1.921 | 0.091 |
| *lnRCA* | 1.450 | 0.455 | 3.191 | 0.013 | –4.153 | 1.240 | –3.349 | 0.010 |
| *lnRCAI* | 1.492 | 0.441 | 3.382 | 0.010 | 2.288 | 0.513 | 4.458 | 0.002 |
| $R^2$ | 0.614 | | | | 0.506 | | | |
| Poland | | | | | | | | |
| *const* | –3.846 | 1.363 | –2.821 | 0.022 | –3.866 | 1.411 | –2.740 | 0.025 |
| *lnRCA* | 2.882 | 1.073 | 2.684 | 0.028 | 2.761 | 0.890 | 3.102 | 0.015 |
| *lnRCAI* | 2.576 | 1.083 | 2.378 | 0.045 | 4.381 | 1.856 | 2.360 | 0.046 |
| $R^2$ | 0.548 | | | | 0.678 | | | |
| Slovakia | | | | | | | | |
| *const* | –5.797 | 1.144 | –5.067 | 0.001 | 0.345 | 0.110 | 3.148 | 0.014 |
| *lnRCA* | 2.914 | 1.118 | 2.606 | 0.031 | 3.484 | 1.783 | 1.954 | 0.086 |
| *lnRCAI* | 2.080 | 0.720 | 2.890 | 0.020 | 3.828 | 0.908 | 4.215 | 0.003 |
| $R^2$ | 0.533 | | | | 0.401 | | | |

Source: the author's calculations.

rate of diffusion of mobile technology by an average of about 4.153%. The negative impact of the comparative advantage on the *GRG* index in some V4 countries may be a consequence of the fact that the share of technologically advanced goods constitutes only a small part of the foreign trade of the V4 countries (at most a dozen or so percent). In addition, having an advantage in foreign trade in high-tech industries can demotivate the propensity of local producers to innovate. Only the increase of foreign competitiveness in trade stimulates domestic companies, "forcing" them to innovate and thus also activating the processes of innovation diffusion. In turn, the inflow of FDI to the V4 countries is still growing and has recently achieved significant dynamics despite the worldwide economic crisis caused by the COVID-19 pandemic. The Visegrad countries have effectively taken advantage of

the global trend of shortening supply chains due to the pandemic and have become attractive locations to foreign investors.

It can be concluded that industries with low- and medium-low technologies currently provide better conditions for the absorption of mobile technology compared to high and medium technology industries. One of the reasons for this may be that the Visegrad economies still have a small share of industries with very advanced technologies compared to industries with less advanced technologies.

## 5. Conclusions

The results confirm that the choice of the Gompertz function was appropriate for modelling the diffusion of mobile technologies. This choice is consistent with the results obtained by other researchers in similar analyses conducted for other European (Meade & Islam, 1995) and non-European countries (Liu, Wu & Chu, 2009; Liu *et al*., 2014).

The research shows that the diffusion of mobile technologies in the Visegrad four countries takes place in different industries, but its speed varies depending on the technological advancement of the industry.

The research done for this paper has also shown that the phases of increasing rates of innovation diffusion are clearly longer in high- and medium-high technology industries than in low- and medium-low technology ones. Lower dynamics of diffusion of mobile technology in high- and medium-high technology industries in Poland and Hungary (compared to low- and medium-low technology industries) may indicate the existence of barriers to the diffusion process in some high-tech industries or the possibility of developing innovation through channels other than diffusion. The study shows that in industries with low- and medium-low technology, both export specialisation and investment attractiveness support the diffusion of mobile technology in V4 countries. In the short term, in low- and medium-low technology industries, both foreign trade and foreign direct investment are important transmission channels for innovation diffusion, while in the case of high-tech and medium-high technology industries, foreign direct investments are such a channel. Therefore, strengthening the competitive position of companies on foreign markets as well as introducing support systems for foreign investors on the domestic market are conducive to the diffusion of innovation.

In high- and medium-tech industries, comparative advantage in exports inhibits the diffusion of innovation. Thus, in these industries, the weakening position of domestic enterprises on foreign markets and their displacement by external competition may be a motivating factor for strengthening the innovation process in enterprises. The obtained results indicate the need to develop industries with high technologies and sectors with a high intensity of knowledge, whose share in the economy is still giving way to less technologically advanced industries.

Lastly, one limitation of this research is that the models presented here were built on the basis of a small amount of data (relatively short time series). In future research, using longer time series will make it possible to produce models that better fit the empirical data.

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### Conflict of Interest

The author declares no conflict of interest.

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# Innovation in Decision-making Models Applied by Enterprises: Determinants of Organisational Innovation

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## ABSTRACT

**Objective:** The paper addresses innovation as a vital issue in management. The meaning of innovation is analysed in knowledge management and business strategy. The intention of the article is to present the innovation issue from the model perspective and to illustrate the mentioned matters based on research results.
**Research Design & Methods:** The research problem was how to apply innovation in a decision-making model and describing the determinants of its implementation.
**Findings:** The findings help address a number of results. The study tests a decision-making model, collaboration between managers in enterprises, and their support for innovation.
**Implications/Recommendations:** When making decisions, enterprises must account for problems brought about by innovation in their current operations and strategy. Unfortunately, upwards of 40% of enterprises do not cooperate with research and development organisations. Further research will be required to understand why not.
**Contribution:** This study has a range of implications for innovation researchers. It argues for increased attention to the decision-making process in the context of organisational innovation.

**Article type:** original article.

**Keywords:** innovation in decision-making models, organisational innovation, determinants, enterprise.

**JEL Classification:** O30.

## 1. Introduction

In the study of management theory, innovation is approached from multiple perspectives. One of the most important is the model-based analysis of innovation, which is the foundation for the growth of every business. Growth is assured by the right decisions which, considering their complexity derived from multiple structural variants, require a definition of innovation and the structuring of the aspects of innovation in business enterprises. With a conference being held jointly with the 50th anniversary of Professor Janusz Czekaj's academic career, organisational innovation became the central matter.

The starting point is the area of knowledge management that is needed to create new products and technologies (Morawski, 2014). Knowledge of the potential of consumers' information requirements defined in market challenges is equally important (Kieżel, 2018). Most advanced technology innovation, targeted at the growth and modern transformation of businesses as well as collaboration with the research and development (R&D) sector, rises to such challenges (Jasińska-Biliczak, 2017). A strategic perspective needs to be included in the analysis of the the impact of these areas of innovation. The primary objectives of innovation and the boundary conditions for its implementation are of particular importance (Mielcarek, 2017). Setting up the goal of innovation properly within the area defined by the boundary conditions enables business performance to grow through innovation.

While innovation enables an increase in enterprise performance and is in itself complex and multifaceted, it requires certain generalisation and simplification processes (Garud, Tuertscher & Van de Ven, 2013). These can be achieved through the model presentation of innovation, based on unique decision identifiers that support the integration of distributed heterogeneous data into management processes (Szpitter, 2020). The base of those processes is the product of diverse impact factors and conditions, providing grounds for a model-based presentation of innovation decisions. The innovation-oriented competing values framework should be specifically emphasised here (Czekaj & Ziębicki, 2013).

In model-based perspectives, organisational innovation should be highlighted. Organisational innovation is defined as action that enables the adaptation of anything new within an organisation. Professor Janusz Czekaj has analysed organisational

innovation from two perspectives. One identifies organisational innovation with an idea, practice, or material artefact recognised as new by the implementing organisation. The other identifies organisational innovation as a multiple-aspect presentation of new products, methods, combinations, or synthetic knowledge launches (Czekaj & Ćwiklicki, 2014). The outputs of such measures, adopted in original products or services, create new values for the customer, who takes advantage of the value innovation in this way (Skowron-Grabowska, 2021). Taking these aspects of innovation into account, modelling of decision-making processes at an enterprise is key, as are innovation conditions in the context of knowledge management.

## 2. The Conditions and Essence of Innovation from the Perspective of Knowledge Management

The conference entitled "Managing organisations in the digital age. Challenges, trends, concepts" is a special challenge for the academic staff. The conference is being held to commemorate the 50th anniversary of Professor Janusz Czekaj's academic career.

Professor Czekaj's anniversary and the subject matter to be covered at the conference encourages reflection on his highly creative work. While Professor Czekaj has covered a broad spectrum of thought in his myriad papers, further analysis here will be limited to organisational innovation as a fundamental research problem in the discipline of management studies.

Organisation management largely applies to the processes of creating and developing new methods in response to the challenges faced by enterprises operating in competitive markets. Professors Czekaj and Ćwiklicki have pointed out that the above processes can be viewed from two perspectives: conceptual and utilitarian. The conceptual focuses on effective and smooth management concepts, driving changes in objectives, value creation, and the systems in which enterprises operate. The second concerns enterprise growth and the specification of enterprise operations in the form of practical solutions integrating various concepts and paradigms (Czekaj & Ćwiklicki, 2014). The integration processes enable the implementation of innovation at enterprises. For innovation to be brought into existence, adequate actions, relationships, and conditions need to occur (Table 1).

The below presentation considers the perspective of an enterprise – with its resources, creativity, entrepreneurial skills, and orientation – on innovation. Resources may help to create key competences which help determine a strategy (Kaczmarek, 2022). Types of innovation are further indicated in terms of fundamental prerequisites for the incubation and transformation of management processes (Czekaj & Ćwiklicki, 2014).

Transformation processes largely define the innovation at enterprises that are launching a new or significantly modified product, new marketing (Wiktor, 2016) or organisational methods, new workplace organisation, or a change in external relations. Innovation is viewed as the key to growth, which creates elements of an organisation's strategy. The above-mentioned innovation measures are analysed in the context of functional strategy, and incorporated into the organisation's overall innovation strategy (Sołtysik, 2020). Innovation undertaken upon the initiative of consumer organisations has also proven important (Kaplan, 1998). Ultimately, innovation is embedded in strategic management (Zakrzewska-Bielawska, 2014).

Table 1. Resources and Relationships in Enterprise Management from the Innovation Perspective*

| Enterprises | Customer | Market |
|---|---|---|
| – Resources/knowledge<br>– Creativity<br>– Entrepreneurship<br>– Innovativeness<br>– Key Enabling Technologies<br>– Concepts, methods, strategies | – New needs creation processes<br>– Value innovation | – Relationships between organisations<br>– Value resource transfer<br>– Networked structure<br>– Evolutionary trend |

* Due to the subject matter of the analysis, types of innovation are not specified in detail. They have been classified by Hintze (2015), among others.

Source: the author, based on (Czekaj & Ćwiklicki, 2014).

In order to relate innovation to management studies, including strategic management, the context of knowledge management needs to be understood (Michna, 2017). Knowledge management is identified with the targeted designing of processes, methods, and structures in order to enhance, renew, share, or improve the use of knowledge (Hamid, Mahmood & Khalaf, 2021). Two types of knowledge are at work in knowledge management – the knowledge necessary to create new products and technologies, and knowledge of the potential needs of innovation consumers (Pichlak, 2020). For instance, implementing innovation in photovoltaics has garnered a great deal of consumer interest over the past decade (Buła, Schroeder & Ziółko, 2020). International collaboration is an important source of knowledge acquisition (Mesjasz, 2017). Selected aspects of knowledge management and innovation point to the need for organisations to collaborate in this area. Collaboration in innovation processes can take the following forms (Pittino & Visintin, 2009):

– defensive, with companies primarily using their own knowledge resources and undertaking incremental innovation,

– exploratory, arising from a radical innovator attitude, focused on the broad use of external sources of knowledge,

– analytic, as the outcome of choosing partners to implement innovation in response to new market trends; particularly digital technologies (Buarque *et al*., 2020),

– reactive, focusing on setting up collaboration based on the need to use external knowledge, aiming at improving proposals or implementing innovation internally.

Innovation characterised by the most advanced technologies drives pro-growth actions at enterprises engaged in modern transformation. Such innovation has the R&D sector's activity at the source, delivering innovative projects for enterprises as complete solutions or in coordination with business operators (Głód & Swałek, 2021). This collaboration is based primarily on the transfer of knowledge and support of innovation activities of undertakings (Knop, Szczepanik & Olko, 2014). An enterprise collaboration may have negative or positive effects, of course, but it could become a chance for development (Kaczmarek *et al*., 2021). A strategic approach is an important aspect of innovation in enterprises, where innovation strategy is used to translate the primary goal into specific innovation objectives. It also defines the boundary conditions for innovation, specifying the fundamental assumptions to enable the effective implementation of innovative solutions (Malara, 2013).

A number of requirements should be addressed in implementing an innovation strategy (Sosnowska, 2013):

– achieving cohesion of the innovation framework and the competition strategy adopted,

– ensuring the right relationships within the innovation subsystem and other subsystems in the organisation to deliver the synergy effects,

– improving the organisation's performance driven by innovation.

These conditions form a decision-making base for initiating and implementing innovation. With an understanding of the overall complexity of innovation and the issues surrounding it, we now turn to the model approach as it pertains to organisational innovation.

## 3. Model Approach to Decision-making Conditions versus Organisational Innovation

Model approaches play an important role in decision-making at enterprises. In these approaches, unique decision identifiers support the integration of distributed, non-uniform, heterogeneous data, creating a base in the management process (Szpitter, 2020). At that point, it is important to analyse the conditions in the mobile environment in order to create interactions in models used in the enterprise's decision-making processes.

Decisions are the function of multiple different factors (Sopińska & Dziurski, 2018), including (Szymura-Tyc, 2011):

– globalisation,

– lowering the risks at a single enterprise, balanced by a network,

– creating new concepts that improve the utilisation of knowledge resources through advanced IT systems.

Each of these factors provides grounds for a model-based presentation of the matters of knowledge- and innovation-oriented management (Hisrich & Ramadani, 2017). Among multiple diverse perspectives in the model approach, the concentration value model, which, due to its character, is based on integration, can be distinguished. Integration involves four management models: rational goal, internal process, interpersonal relationship, and open systems. Which model is adopted depends on the development phase of the specific organisation. The first, initial phase should be based on the rational goal model. The subsequent phases, corresponding to the organisation's growth, should focus on the internal process model, followed by the interpersonal relationship model and the open system model (Czekaj & Zięb icki, 2013).

Model architectures can be viewed from various perspectives, including the characteristics of the goals, tasks, contacts, relationships, and technologies. All together, these form the qualitatively unique internal workings of an enterprise with a large number of linked tasks (Tubielewicz, 2013). Discussion of the integration and variable character of innovation at organisations tends to focus mainly on the model approach (Brzeziński, 2015). The following models can be distinguished in one of the approaches, which are essential for innovation (Brzeziński, 2015):

– supply-based, where the basis is defined by the linear model of innovation,

– demand-based, also relying on the linear model of innovation,

– interactive, including a mixed demand and supply model involving feedback relationships,

– interactive, including a mixed demand and supply model involving chain link relationships,

– networked,

– open innovation.

Considering the diversity of the model approaches and the objective of this paper, the emphasis here shall be placed on the importance of organisational innovation in an enterprise. Broadly speaking, organisational innovation means that the enterprise is oriented toward the creation and implementation of various types of innovation. The model perspective justifies the emphasis of the multidimensional character of innovation as a part of demonstrating the innovation potential of the enterprise. However, determining an enterprise's innovation level can be identified with the

general ability to develop and adapt new projects, whether material (technology) or intangible (such as organisational innovation).

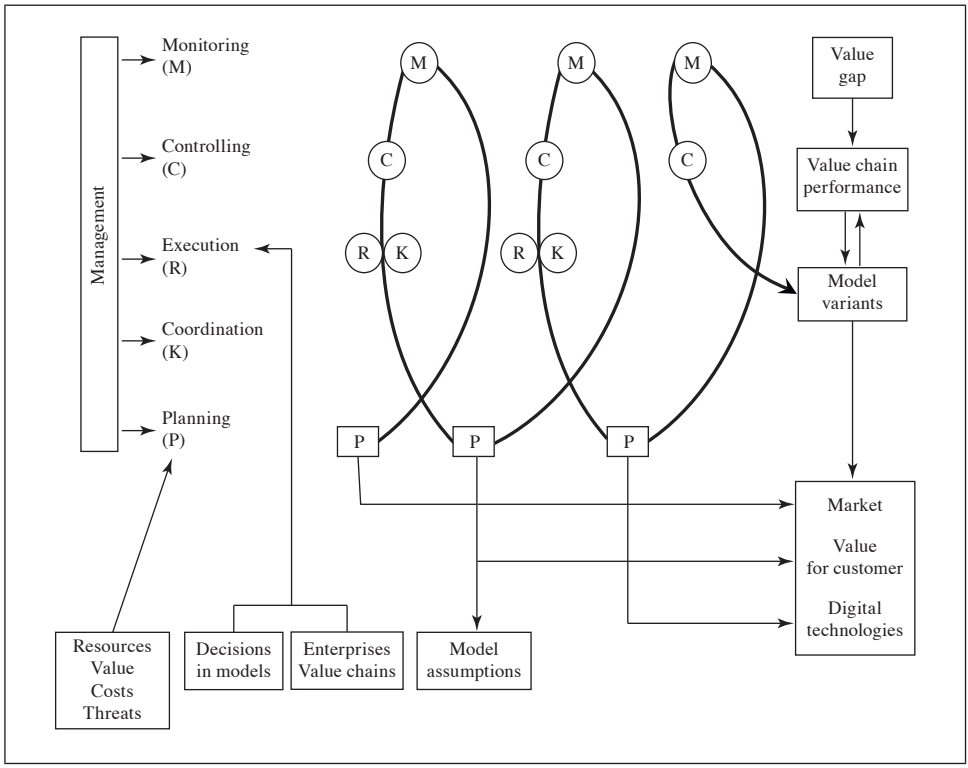


Fig. 1. Modelling Decision-making Processes within Value Chains
Source: (Skowron-Grabowska, 2021, p. 157).

This type of activity is also distinguished in the interpretation of organisational innovation as an adaptation of anything new in the organisation. Then, organisational innovation can be analysed in its two meanings – either as an idea, practice, or material artefact considered to be new by the implementing organisation; or as a broad perspective on the process of launching a new item, method, combination, or synthetic knowledge adopted in original products or services that create new value (Czekaj & Ćwiklicki, 2014). Organisational innovation-oriented processes are of special importance. The process approach will then translate into "lean management, new approaches to work organisation (5S programme), new strategic management methodologies (Balanced Scorecard)" (Czekaj & Ćwiklicki, 2014). Strategic

management, in which the logic of an enterprise's actions in the model perspective focuses on implementing innovation projects, is particularly important. According to Krupski (2014), innovation inspires new strategic management paradigms. The model approach to decision-making instruments leads to the creation of innovation, with value innovation being particularly important (Skowron-Grabowska, 2021). Value innovation starts with the enterprise's attitude toward shareholders and its willingness to collaborate in different areas to create value for customers through innovation (Klimek & Żelazko, 2020).

Modelling decision-making processes at enterprises is a final important issue (Fig. 1). The idea of the analysis was transposed to management, from planning through coordination and ultimately the accomplishment of targets and objectives.

## 4. Analysis of Innovation Activity Based on Empirical Studies

Taking into account the prior theoretical discussion, particularly the context of Professor Czekaj's creative accomplishments, I have used my own empirical/pilot studies to verify the importance of organisational innovation for 107 manufacturing businesses. The management of these enterprise first described their collaboration with the R&D sector (Table 2).

Table 2. Answers to Question 1 (Number of Enterprises)

| Are the enterprises engaged in research and development collaboration with R&D sector organisations? | |
|---|---|
| Yes | 61 |
| No | 28 |
| Don't know | 18 |
| Total | 107 |

Source: the author, based on a survey questionnaire.

Table 3. Answers to Question 3 (Number of Enterprises)

| Do decision-making models enable management to develop innovation at the enterprises? | |
|---|---|
| Yes | 75 |
| No | 11 |
| Don't know | 21 |
| Total | 107 |

Source: the author, based on a survey questionnaire.

The central research question were whether the enterprises collaborated on research and development with R&D sector organisations, and what the criteria for implementing such organisational innovation were.

Question 2 refers to the issue of the development and usability of decision--making models in the field of innovation activities (Table 3). 70% of the surveyed enterprises stated that the models were reasonable and useful.

Question 3 focused on the determination of the percentage of organisational innovation within the overall quantity of innovation implemented at an enterprise (Table 4). The responses show that 35% of all the implemented innovation is represented by organisational innovation.

A general conclusion is that notwithstanding the low level of interest in collaboration with the R&D sector among enterprises, organisational innovation is important for staff.

Table 4. Proportion of Organisational Innovation in the Innovation Activities (Number of Enterprises)

| What is the proportion of organisational innovation in the enterprises' innovation activities? | |
|---|---|
| Organisation innovation | 38 |
| Other types of innovation | 69 |

Source: the author, based on a survey questionnaire.

The chi-square statistic can be used to measure the degree of dependence between the qualitative characteristics corresponding to the questions in the survey questionnaire. In the chi-square test of independence, the null hypothesis of the lack of correlation between the tested variables is verified against the alternative hypothesis of the existence of a significant relationship between the analysed features. The test of the hypothesis is the chi-square statistic:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(n_{ij} - \hat{n}_{ij})^2}{\hat{n}_{ij}}, \tag{1}$$

where:

$n_{ij}$ – empirical numbers presented in a contingency table with $r$ rows and $k$ columns,

$\hat{n}_{ij}$ – theoretical (expected) numbers estimated based on the following formula:

$$\hat{n}_{ij} = \frac{n_{i.} \cdot n_{.j}}{n}, \tag{2}$$

where:

$n_{i.}$ – the number of observations in the $i$-th row of the contingency table,

$n_{.j}$ – the number of observations in the $j$-th column of the contingency table,

$n$ – statistical sample size.

Assuming the null hypothesis is true, the test statistic has a chi-square distribution with $(r-1)(k-1)$ degrees of freedom.

The chi-square test can be used in empirical studies if the counts of individual cells in the contingency table are not less than 5. If the empirical counts in the contingency table are relatively small, the chi-square statistic revised by Yates's correction for continuity can be determined:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{\left(n_{ij} - \hat{n}_{ij} - 0.5\right)^2}{\hat{n}_{ij}}. \tag{3}$$

In this paper, the chi-square test of independence was used to identify significant relationships between organisational innovation and other types of innovation.

At the significance level of 0.05, there is no grounds to reject the null hypothesis that there is no relationship between the distribution of answers to question 3 and the classification (grouping) of the surveyed enterprises based on demographic characteristics 1 and 2. This means that characteristic 1 did not differentiate production enterprises due to the choice of innovation type (organisational or other). Similarly, the chi-square statistic values (0.09; 0.01) indicate no significant links between the choice of innovation type by enterprises and characteristic 2 (Tables 5–7). That is, this characteristic did not differentiate enterprises in terms of the type of innovations they implemented.

Table 5. Distribution of Answers to Question 3 by Variants of Demographic Characteristic 1

| Demographic Characteristic 1 | Question 3 | | |
|---|---|---|---|
| | organisational innovation | other types of innovation | total |
| Variant 1 | 7 | 17 | 24 |
| Variant 2 | 31 | 52 | 83 |
| Total | 38 | 69 | 107 |

Source: the author, based on a survey questionnaire.

Table 6. Distribution of Answers to Question 3 by Variants of Demographic Characteristic 2

| Demographic Characteristic 2 | Question 3 | | |
|---|---|---|---|
| | organisational innovation | other types of innovation | total |
| Variant 1 | 17 | 33 | 50 |
| Variant 2 | 21 | 36 | 57 |
| Total | 38 | 69 | 107 |

Source: the author, based on a survey questionnaire.

Table 7. Chi-square Statistic (Is There a Relationship between Demographic Characteristics 1, 2, 3 and the Distribution of Answers to Question 3?)

| Specification | Question 3 | | |
|---|---|---|---|
| | characteristic 1 | characteristic 2 | characteristic 3 |
| Chi-square statistic | 0.54 [0.4607] | 0.09 [0.7592] | 35.87 [0.0000] |
| Yates's correction for continuity | 0.25 [0.6202] | 0.01 [0.9171] | 33.49 [0.0000] |

Notes: *p*-values are given in parentheses.

Source: the author, calculations done in Statistica 13.3.

Table 8. Distribution of Answers to Question 3 by Variants of Demographic Characteristic 3

| Demographic Characteristic 3 | Question 3 | | |
|---|---|---|---|
| | organisational innovation | other types of innovation | total |
| Variant 1 | 4 | 49 | 53 |
| Variant 2 | 34 | 20 | 54 |
| Total | 38 | 69 | 107 |

Source: the author, based on a survey questionnaire.

Based on the estimated value of the chi-square statistic – 35.87 [0.0000] (corrected for Yates continuity to 33.49 [0.0000]) – the null hypothesis must be rejected in favour of the alternative hypothesis at a significance level of 0.05. This means that characteristic 3 significantly differentiates enterprises by innovation type. The data in Table 8 show that enterprises with variant 1 of characteristic 3 tend to create other innovations, whereas enterprises with variant 2 of characteristic 3 more frequently create organisational innovations.

Based on a significance level of 0.05, there is no evidence to reject the null hypothesis that there is no correlation between the distribution of answers to question 1 and the classification of enterprises according to characteristic 1. This indicates that characteristic 1 does not distinguish manufacturing companies in terms of engagement in research and development collaboration with R&D sector organisations. However, in two subsequent cases, the null hypothesis should be rejected in favour of the alternative hypothesis at a significance level of 0.05. This suggests that characteristics 2 and 3 had a significant impact on the engagement of enterprises in research and development collaboration with R&D sector organisations (Table 9). Upon analysing Table 10, it is evident that enterprises with variant 1 of characteristic 2 were more likely to be involved in R&D. Meanwhile, enterprises with variant 2 of characteristic 2 were not involved in R&D or the respondents had no knowledge of the topic. Additionally, from Table 11, it can be seen that enter-

prises with variant 2 of characteristic 3 were often involved in R&D, while enterprises with variant 1 of characteristic 3 did not engage in R&D or the respondents were not aware of such activities (Table 12).

Table 9. Distribution of Answers to Question 1 by Variants of Demographic Characteristic 1

| Demographic Characteristic 1 | Question 1 | | | |
|---|---|---|---|---|
| | yes | no | don't know | total |
| Variant 1 | 20 | 9 | 8 | 37 |
| Variant 2 | 41 | 19 | 10 | 70 |
| Total | 61 | 28 | 18 | 107 |

Source: the author, based on a survey questionnaire.

Table 10. Distribution of Answers to Question 1 by Variants of Demographic Characteristic 2

| Demographic Characteristic 2 | Question 1 | | | |
|---|---|---|---|---|
| | yes | no | don't know | total |
| Variant 1 | 43 | 11 | 11 | 65 |
| Variant 2 | 18 | 17 | 7 | 42 |
| Total | 61 | 28 | 18 | 107 |

Source: the author, based on a survey questionnaire.

Table 11. Distribution of Answers to Question 1 by Variants of Demographic Characteristic 3

| Demographic Characteristic 3 | Question 1 | | | |
|---|---|---|---|---|
| | yes | no | don't know | total |
| Variant 1 | 9 | 22 | 13 | 44 |
| Variant 2 | 52 | 6 | 5 | 63 |
| Total | 61 | 28 | 18 | 107 |

Source: the author, based on a survey questionnaire.

Table 12. Chi-square Statistic (Is There a Relationship between Demographic Characteristics 1, 2, 3 and the Distribution of Answers to Question 1?)

| Specification | Question 1 | | |
|---|---|---|---|
| | characteristic 1 | characteristic 2 | characteristic 3 |
| Chi-square statistic | 0.934 [0.6267] | 7.839 [0.0198] | 40.927 [0.0000] |
| Yates's correction for continuity | 0.977 [0.6137] | 7.849 [0.0197] | 40.728 [0.0000] |

Notes: *p*-values are given in parentheses.

Source: the author, calculations done in Statistica 13.3.

Based on the significance level of 0.05, there is no evidence to reject the null hypothesis that there is no correlation between the distribution of answers to question 2 and the demographic characteristic 1 of the surveyed manufacturing enterprises. This suggests that characteristic 1 did not differentiate these enterprises in terms of decision-making models for developing innovation concepts. However, the null hypothesis should be rejected in favour of the alternative hypothesis for characteristics 2 and 3, indicating that they significantly impact decision-making models for developing innovation (Table 13). The results in Table 14 show that enterprises with variant 2 of characteristic 2 more often confirmed the existence of decision-making models that enabled management to develop innovation (79%) than those with variant 1 (57%). Similar observations were made for characteristics 3 and 2 in Table 15, where enterprises with variant 2 of characteristic 3 more often confirmed the existence of decision-making models that enabled management to develop innovation at the enterprises (84%) than those with variant 1 (48%). The data presented in Table 16 confirms that there is a relationship between demographic characteristics 1, 2, 3 and the distribution of the answers to question.

Table 13. Distribution of Answers to Question 2 by Variants of Demographic Characteristic 1

| Demographic Characteristic 1 | Question 2 | | | |
|---|---|---|---|---|
| | yes | no | cannot say | total |
| Variant 1 | 29 | 5 | 8 | 42 |
| Variant 2 | 46 | 8 | 11 | 65 |
| Total | 75 | 13 | 19 | 107 |

Source: the author, based on a survey questionnaire.

Table 14. Distribution of Answers to Question 2 by Variants of Demographic Characteristic 2

| Demographic Characteristic 2 | Question 2 | | | |
|---|---|---|---|---|
| | yes | no | cannot say | total |
| Variant 1 | 25 | 8 | 11 | 44 |
| Variant 2 | 50 | 5 | 8 | 63 |
| Total | 75 | 13 | 19 | 107 |

Source: the author, based on a survey questionnaire.

The support and engagement of management are required for the design and implementation of innovation because implemented innovation usually leads to multiple significant changes in the organisation's operations. Changes in the model apply to the organisational structure, formation of project teams, and acceptance of innovation (Skowron-Grabowska & Jasińska, 2019). The broad spectrum of activi-

ties poses a challenge to managers who support the implementation of innovation, including organisational innovation (Wuttke, Blome & Protopappa-Sieke, 2012).

Table 15. Distribution of Answers to Question 2 by Variants of Demographic Characteristic 3

| Demographic Characteristic 3 | Question 2 | | | |
|---|---|---|---|---|
| | yes | no | cannot say | total |
| Variant 1 | 19 | 8 | 13 | 40 |
| Variant 2 | 56 | 5 | 6 | 67 |
| Total | 75 | 13 | 19 | 107 |

Source: the author, based on a survey questionnaire.

Table 16. Chi-square Statistic (Is There a Relationship between Demographic Characteristics 1, 2, 3 and the Distribution of Answers to Question 2?)

| Specification | Question 2 | | |
|---|---|---|---|
| | characteristic 1 | characteristic 2 | characteristic 3 |
| Chi-square statistic | 0.079 [0.9612] | 6.325 [0.0423] | 15.712 [0.0004] |
| Yates's correction for consistency | 0.2156 [0.8978] | 6.257 [0.0438] | 15.399 [0.0005] |

Notes: *p*-values are given in parentheses.

Source: the author, calculations done in Statistica 13.3.

Hatcher and team emphasise that workers follow diverse motives when participating in decision-making processes (Hatcher, Ross & Collins, 1991). The prevailing motivation is to help improve individual and organisational performance and to make work easier (Biłyk, 2020). Other studies of American workers indicate that they "expect to have a greater influence on decisions taken in areas related to the planning and organising of their own work and to working methods. Decisions about company policy or staffing policy were less popular" (Biłyk, 2020).

These results suggest that workers are largely interested in organisational innovation. The need for innovation-related patents should be emphasised. High technology innovation creates areas where performance improvement occurs as a result of patent implementation projects (Wanzenböck, Neuländtner & Scherngell, 2020). The report, "Capital of Intangible Goods within Global Value Chains" (Lisowska-Bilińska, 2017) was among the first to discuss the value of intangible goods, which represented almost one-third of the global sum of goods produced and sold worldwide during 2010–2014. Their input largely increased the value of products and was primarily focused on the broadly defined telecommunication and IT sectors (Lisowska-Bilińska, 2017). "Key Enabling Technologies (KETs) are a significant extension of

the research. KETs are knowledge-intensive and associated with high R&D intensity, rapid innovation cycles, largescale capital expenditures, and highly-skilled employment. They enable processes, goods, and service innovation through the economy. They are multidisciplinary, cutting across many areas of technology with a trend toward convergence and integration" (European Commission, 2009).

For example, knowledge management models in the context of patent operations in German regions were identified in KET research. Five types of models were distinguished in the innovation area in the regions, mainly emphasising the number of patents per region, their structure, and sources of knowledge creation. The importance of nanotechnologies with interactive knowledge deliverables in the region was likewise underscored (Wessendorf, Kopka & Fornahl, 2021).

The conclusions of the empirical studies are as follows:

– enterprises do engage in innovation activities, yet only 57% of them collaborate with the R&D sector,

– management and personnel implement organisational innovation as it has an immediate effect on how the workplace is organised,

– patents play an important role in innovation activities, as they are based on knowledge management processes.

## 5. Recommendations

As the review of the literature and empirical research suggests, innovation, particularly organisational innovations play a crucial role in decision-making processes. My finding also suggest it would be beneficial to conduct further research on guiding managerial staff toward an innovative approach in enterprises. The study revealed that the implementation of innovations has a similar structure, with a low percentage of organsational innovations. The reasons for this trend, along with ways to increase organisational innovation in enterprises, remains a topic for investigation. The present research provides a basis for further and independent analyses of enterprises.

## 6. Summary

A general analysis of innovation and knowledge management in enterprises reveals the importance of these matters, both in the day-to-day operations and in strategy. Of the selected range of activities, implemented innovation needs to be emphasised, yet it seems reasonable to expand still further the collaboration between businesses and the R&D sector. As a result, a major extension of innovation activities at enterprises will become a realistic prospect.

Particular attention should be given to organisational innovation, the importance of which is based on the immediate interest among the workforce seeking

to implement multiple organisational improvements at their workplaces. Bottom-up workforce initiatives, in coordination with management, are ripe grounds for implementing organisational innovation.

### Conflict of Interest

The author declares no conflict of interest.

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# Towards Better Knowledge Valorisation: The Perspective of Representatives of the European Commission

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## ABSTRACT

**Objective:** The aim of the article is to provide a perspective on the perception of knowledge valorisation by representatives of the European Commission and to answer the following questions: Does knowledge valorisation require the development of a special strategy? What contributes to valorisation success? What hinders knowledge valorisation? How can progress in knowledge valorisation be assessed?

**Research Design & Methods:** Qualitative research was conducted in the form of a group interview with representatives of the European Commission.

**Findings:** According to the European Commission representatives, steps in the field of knowledge valorisation are becoming a priority, but still remain a challenge. To ensure the success of valorisation, the involvement of all participants in the research and innovation ecosystem is essential, with universities playing a key role in this process. By creating knowledge that benefits citizens, scientists influence changes in their behaviours, which can contribute to economic, social, and environmental benefits. Unfortunately, this process is burdened by many barriers, and the lack of specific guidelines for measuring and evaluating social impact is a significant hindrance.

**Implications/Recommendations:** Though it does not provide specific metrics of social impact, the Europen Commission does support Member States by sharing the most up-to-date knowledge through its knowledge valorisation platform.
**Contribution:** The article presents the perspective of representatives of the European Commission on knowledge valorisation.

**Article type:** original article.

**Keywords:** knowledge valorisation, social impact, university, European Commission.

**JEL Classification:** O31, O34, O35, I23.

## 1. Introduction

Converting scientific breakthroughs into effective solutions that can be applied in practice is a major challenge currently facing institutions of higher education. Science is envisaged as a propulsive force capable of addressing societal challenges, and it cannot remain unaffected to the ongoing ecological and digital metamorphoses. Thus, enhancing the accessibility to and utilisation of findings from scientific inquiry, particularly those funded by public resources, is of paramount importance. The European Union emphasises maximising the social and economic value of research and innovation (European Commission, 2024a).

The Directorate-General for Research and Innovation of the European Commission is responsible for the European Union's policy on research and innovation. Given this, it is particularly interesting to learn about the perspective of representatives of the European Commission with regard to these questions:

1. Does knowledge valorisation require the development of a special strategy?
2. What contributes to successful valorisation?
3. What hinders the valorisation of knowledge?
4. How should progress in knowledge valorisation be assessed?

Answering these questions is the aim of this study. Qualitative research in the form of a group interview was conducted. The article is of a theoretical-empirical nature. The first part defines the valorisation of knowledge, the next describes the research methodology, and the third section presents the most important results. Conclusions from the research along with limitations and potential directions for future research round out the paper.

## 2. A Definition of Knowledge Valorisation

Defining knowledge valorisation requires a range of related concepts to be explained (Andriessen, 2005). It is important to recognise the links between knowledge commercialisation, transfer, and valorisation (Fig. 1).

KNOWLEDGE VALORISATION > KNOWLEDGE TRANSFER > KNOWLEDGE COMMERCIALISATION

Fig. 1. Links between Knowledge Valorisation, Transfer and Commercialisation
Source: the authors.

These terms are interpreted in a variety of ways across the literature. Commercialisation of knowledge is considered the narrowest of the three concepts. It is understood as a set of activities related to providing research results to other entities for a fee or transferring results to such entities (Flisiuk & Gołąbek, 2015; Gierulski, Santarek & Wiśniewska, 2020; Kleiner-Schaefer & Schaefer, 2022). Assuming that knowledge transfer is the flow and exchange of knowledge carried out between those who have knowledge and those who need it (Kumar & Ganesh, 2009), some researchers understand it more broadly than commercialisation, because it refers to both commercial and non-commercial knowledge transfer to the economy (Barszcz, 2016). Knowledge valorisation, on the other hand, involves creating social value from knowledge by translating research results into innovative products, services, processes, and/or business actions (Benneworth & Jongbloed, 2010; de Jong, 2015; Hladchenko, 2016), and it has the broadest scope by far. It can be implemented by creating spin-off companies and filing patent applications, or by publishing and developing guidelines on improving policy (van de Burgwal, Dias & Claassen, 2019). Valorisation not only helps increase the availability of research results beyond academic environments, but is primarily associated with the co-creation of knowledge by scientists and business representatives (Benneworth & Jongbloed, 2010). This process fills the gap between the exploration and exploitation of research results (Garbade *et al*., 2013).

Two documents will be used as a basis for further discussions:

– The Council Recommendation (EU) 2022/2415 of 2 December 2022 on the guiding principles for knowledge valorisation,

– The Commission Recommendation (EU) 2023/499 of 1 March 2023 on a Code of Practice on the management of intellectual assets for knowledge valorisation in the European Research Area.

These documents define knowledge valorisation as "the process of creating social and economic value from knowledge by linking different areas and sectors and transforming data, know-how, and research results into sustainable products, services, solutions, and knowledge-based policies that benefit society" (European Council, 2022). Knowledge valorisation is therefore a complex process, which (European Commission, 2023):

– focuses on increasing the value of current and future scientific research, innovation, and knowledge assets, including key hidden knowledge,

– requires significant resources,

– requires ongoing investment in the development of specialists and mediators in knowledge transfer and intermediation between relevant actors in the field of research and innovation,

– is heavily dependent on the involvement of all actors in the ecosystem of scientific research and innovation, as well as users or beneficiaries of knowledge and innovation, with particular emphasis on the use and reuse of knowledge and mutual inspiration among different sectors for the benefit of society,

– requires the development of strategies and the promotion of specific skills to fully capitalise on the value of intellectual assets and effectively manage them.

Bruneel, D'Este and Salter (2010) and Tartari, Salter and D'Este (2012) both highlighted the numerous barriers to implementing knowledge valorisation. Minimising them requires proven solutions. A knowledge valorisation platform connecting entities in Europe, whose ambition is to transform research results into sustainable products and solutions for the public good, can help in their identification. Such a platform enables sharing of best practices, and listening to the experiences and cooperation others have forged with various partners throughout Europe (European Commission, 2024b).

## 3. Research Methodology

The qualitative research was conducted by means of a group interview. A partially standardised interview based on guidelines took place on 18.10.2023 in Brussels at the European Commission (Directorate-General for Research and Innovation).

A group interview has many advantages and some disadvantages. Authors such as Alsaawi (2014) and Dias and Teles (2023) have described the main benefits, including time saved thanks to the possibility of talking to several people at once, greater control over the quality of the data collected, relatively low implementation costs, and the ability to utilise group dynamics in developing specific issues. Key drawbacks include the need to limit the number of questions and the need to involve a highly competent moderator.

Eight people attended the meeting, including four representatives of the European Commission as experts and four researchers from Lodz University of Technology (the one with the most experience conducting qualitative research was the facilitator, while the others played supporting roles). The selection of respondents was deliberate. Invitations to participate in the study were sent by e-mail. They were addressed to the person in charge of the unit responsible for valorisation policies and intellectual property rights (Head of the unit, European Commission, DG Research & Innovation Unit E.2 – Valorisation policies & IPR). That individual then selected

the three remaining respondents from among colleagues. The interview lasted about an hour and was recorded, with the consent of all participants, on a dictaphone, and then transcribed. The gathered material was subjected to qualitative content analysis (Forman & Damschroder, 2007; Selvi, 2019; Glinka & Czakon, 2021). In describing the research results, selected quotes were used to realistically convey the perception of the respondents and demonstrate that the results were not fabricated by the researcher (Czernek, 2015).

## 4. Results

Respondents were first asked how they perceive the valorisation of knowledge. Representatives of the European Commission believed the valorisation of knowledge presents a challenge, but that actions in this area are becoming a priority. The latter point is evidenced by the fact that numerous Member States have brought forth guidelines on the valorisation of knowledge. They have also shown keen interest in best practices and furthering knowledge on how to implement valorisation at the national level. The important role of universities in this process was emphasised during the interviews. One respondent pointed out that universities, in creating knowledge that benefits citizens benefit, bring about necessary changes in citizen behaviour, which is an extremely important aspect of knowledge valorisation: "We can invent any technology, but if people are not ready for change, for more sustainable options, they won't buy them. (…) If you contribute to the development or change of standards, and thus increase industry competitiveness (…) it is also a way of valorising results (…)".

The European Commission representatives were in agreement that every university should develop a knowledge valorisation strategy and integrate it into the university's overall strategy. To do so, "(…) incentives and skills are needed. Specialised individuals, such as those working in knowledge transfer offices, are also necessary. It is important for researchers, students, and other employees to have a basic understanding of valorisation. And also the kind of ambition and interest in utilising research results to create value".

Internal communication within the organisation, ensuring a smooth flow of information between departments, and then units, as well as individual employees and students, will, in the respondents' opinion, help valorisation progress. Other benefits will include:

– for students, the opportunity to invest their knowledge or other assets, which "(…) gives them a lot of satisfaction and they may even receive a small payment for it, if they sell their knowledge to a company or if they get a job". It was emphasised that by implementing even small projects involving students and companies, key relationships for valorisation successes are established;

– for employees, expressing recognition and appreciation "(…) at meetings, in advertisements, informing about successes".

It was also established that for partners (including companies, public institutions, non-profit organisations) it is important that they be given the opportunity to report problems requiring solutions or those related to current challenges that need to be addressed. The research participants claim that "(…) the increase in awareness that there are possibilities that you can offer to these public organisations and companies, that you have knowledge, you have equipment, laboratories (…). And really, cooperation with the university is an opportunity to meet social challenges that may arise for example in the city (…), it can be something very practical. Perhaps the university can provide resources to solve the problem (…). And then, in order to have these interactions, for scientists to go out and be available to those external, kind of, third-party social entities, to have these connections".

On the other hand, in order to engage key authorities, open dialogue is crucial. "I have seen that some universities have approached local or regional authorities. Are there any social challenges in which we excel (…), and then you could create that kind of alignment with city authorities, perhaps with residents and local companies. And if the city authorities are involved, it will greatly facilitate the process".

Another issue discussed during our meeting with the European Commission representatives was the barriers to knowledge valorisation. One was the need to create publications and base the evaluation of scientists mainly on their publications. The need to change the paradigm, particularly as concerns dead patents, was also pointed out: "(…) We should not push technology into the market, but develop it together with end users (…) to get rid of the system where the university develops something and patents it, and then [wonders] who will use it?".

The next challenge is a lack of understanding of needs and little interest in one's own research: "For example, wow, I didn't think about it, but this could work for this problem that this industry is facing. So, understanding needs, not something like pressure. We just develop technology, and then someone uses it". As a remedy to this barrier, respondents shared a good practice to follow in the hiring process – to ask candidates what they have done to promote the use of their research results.

Another problematic issue mentioned during the interview was the underestimation of existing collaboration and the benefits for all parties involved. For example, a researcher from the UK was cited thus: "We feel that our achievements as an academy are not recognised and once we have such collaboration with industry and we do not have good feedback, such as thank you for what you have done, you have brought a solution". This can lead to discourage future collaboration. Creating good relationships with collaborators and providing feedback for everyone involved can help minimise these problems.

Identifying employees whose research has high valorisation potential and communicating success stories involving them is another important issue that needs improving. "I think we need to become much better in this area in the future and learn from other cultures. It seems that this is also key, as it creates a sense of success". Respondents agreed that this goal motivates them.

In terms of intellectual asset management, regulatory barriers were also pointed out, as was the need to consider differences arising from international cooperation within different legal systems. Finally, reference was made to the world's current geopolitical situation, which may generate new barriers. Initiating or responding to an invitation for new cooperation, it is worth asking oneself with whom one can safely share information, and where to exercise special caution *vis-à-vis* intellectual property.

Although the European Commission does not provide clear guidelines on how to measure progress in the field of knowledge valorisation, it does encourage and organise meetings and events, and publish materials through its knowledge valorisation platform, thus providing all interested parties with access to the most up-to-date knowledge on valorisation.

## 5. Discussion and Conclusions

The opinions of representatives of the European Commission are consistent with the results of research described by various authors in the literature (Hladchenko, 2016; Trust, 2019; Aiello *et al*., 2021). Interest in knowledge valorisation is increasing, and universities, which play a significant role in this process, are becoming increasingly aware of the need to conduct research that has an impact on society. Publishing research results should not be the sole aim for scientists. Searching for solutions to current problems facing society and involving end-users of knowledge in the process of its creation from the outset is the right direction for efforts towards more effective valorisation to take. In this regard, it is difficult not to agree with the opinions of respondents regarding the need to revise the criteria for evaluating scientists, as previously signaled, for example, by Trust (2019). Furthermore, broad collaboration should be seen as a solid foundation for knowledge valorisation, as noted by Hladchenko (2016). At the same time, Bode, Rogan, and Singh's (2019) notion that solving social problems requires cooperation based on the involvement of many stakeholders also aligns with the opinions of respondents from the European Commission.

According to the research on the topic, to achieve the best possible results, an appropriate knowledge valorisation strategy is crucial (Aiello *et al*., 2021), while determining incentives for various stakeholders to engage in activities for knowledge valorisation, and promoting success stories will also play an outsized role.

The research methodology described in this paper had limitations, which indeed had an impact on the results obtained. The first was the short duration of the group interview, which should be attributed to the respondents' numerous commitments. Moreover, the meeting with the European Commission representatives was a one-time event and based on fairly general provisions.

A promising direction for further research would be to expand the study to include individual remote interviews in order to deepen the knowledge acquired during the group interview. Another ambitious challenge would be to undertake research that results in a proposal for a social impact assessment.

### Conflict of Interest

The author declares no conflict of interest.

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